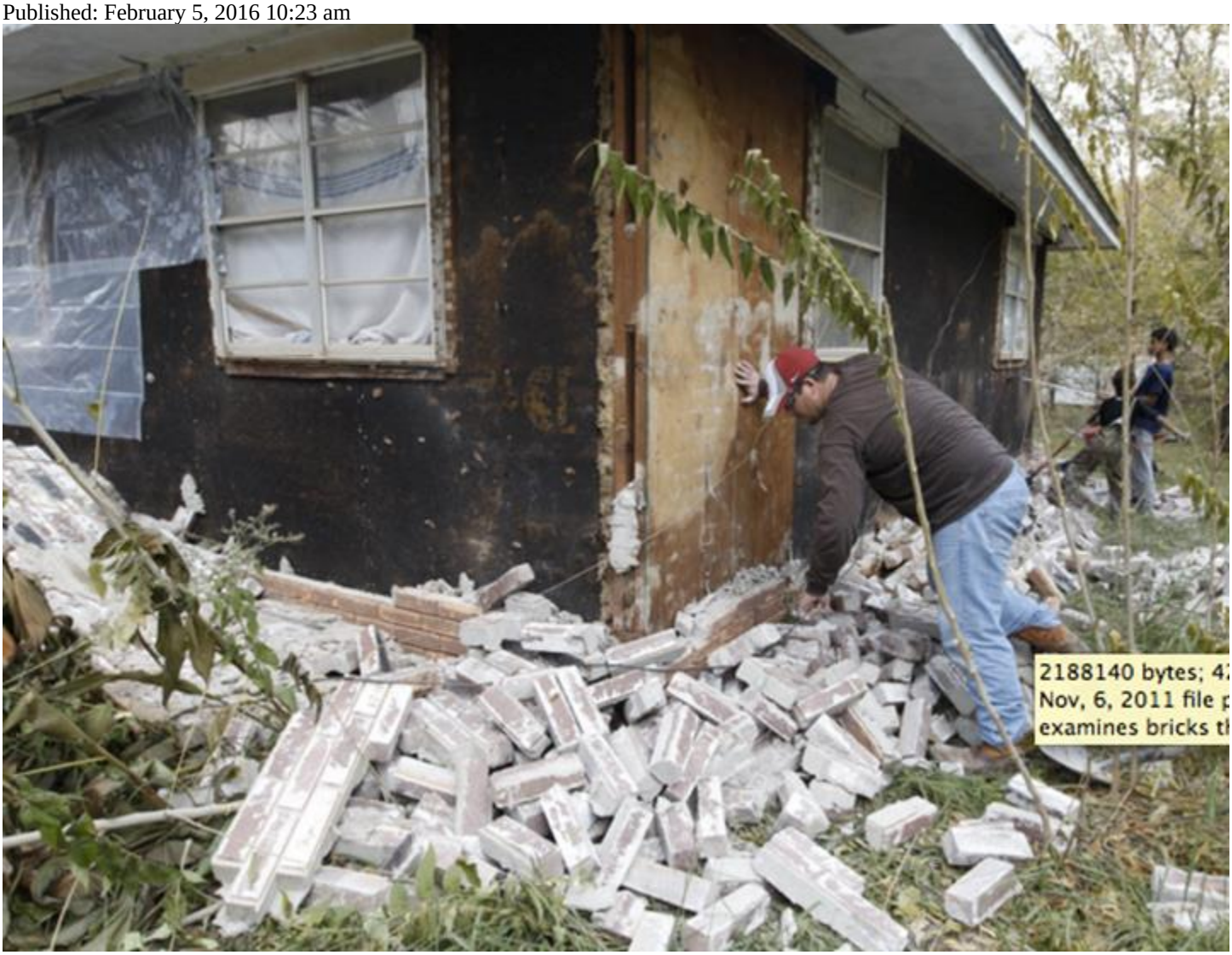
Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, February 05, 2016 12:54 PM
To: Matt Skinner
Subject: FW: Human-triggered quakes can be stopped, says expert

Human-triggered quakes can be stopped, says expert

The Dallas Morning News

Anna Kuchment Follow @akuchment Email akuchment@dallasnews.com
Published: February 5, 2016 10:23 am



In this Nov, 6, 2011 file photo, Chad Devereaux examines bricks that fell from three sides of his in-laws home in Sparks, Okla., following two earthquakes that hit the area in less than 24 hours. (AP Photo/Sue Ogrocki, File)

Earthquakes triggered by oil and gas activity can be stopped if states work to get ahead of the problem, said one of the top experts on human-induced ground-shaking.

“This is a real issue and, just like other environmental impacts of shale gas development, I think it’s manageable, but we have to do the right work in advance,” said Mark Zoback of Stanford University.

Zoback addressed a crowd of students, academics, energy company executives and concerned residents at the University of Texas at Arlington’s department of earth and environmental sciences Thursday afternoon.

Taking steps to prevent human-triggered earthquakes is important, said Zoback, because of the potential for a stronger quake to occur.

Measures that states could take to minimize the risk of such quakes include recycling wastewater instead of injecting it into the ground, as Pennsylvania has done; injecting the fluid into a layer of rock that does not communicate with deep faults; and, when drilling new wells, avoiding faults that have the potential to reactivate.

Very few earthquakes have been linked to hydraulic fracturing, he said.

“There have been 2 million hydrofracs in North America in the last 10 years, and a handful of cases were associated with earthquakes, mostly in Canada,” he said.

The vast majority of human-triggered quakes are related to the process of injecting wastewater from oil and gas operations into deep wells. Operators hydraulically fracture rocks by injecting fluid into wells at high pressure in order to release oil and natural gas. When gas and oil flow up to the surface, fracking fluid and salty groundwater often come with it.

Operators re-inject that fluid into the ground using saltwater – or wastewater — disposal wells.

Zoback explained that pressure from wastewater injections can reduce the friction that holds faults together, causing them to slip and create earthquakes.

Scientists have known that injecting fluid into the ground can cause quakes since at least the 1960s. But the U.S. didn’t see a dramatic rise in its quake rate until around 2011 as the number of saltwater disposal wells took off with the rise of hydraulic fracturing.

Zoback said the central and eastern United States has seen a 500-fold increase in earthquakes in recent years.

“Prior to 2009, a 4-magnitude earthquake would occur every 10 years. Now we see a magnitude-4 quake every week,” he said.

He pointed out that these earthquakes would have occurred anyway, because of the natural stresses that build in the Earth’s crust as tectonic plates shift. But the small added pressures from fluid injection can trigger the earthquakes much sooner.

Until now, Zoback has focused his research on Oklahoma, which accounts for about 70 percent of the increase in earthquakes in the U.S. But he and his colleagues are turning their attention to Texas, where they have been working in parallel and in collaboration with researchers at the University of Texas at Austin and at Southern Methodist University.

They are working to map faults and tectonic stresses across the state and use that information to predict which faults are most likely to become active.

“The challenge is to identify what is not being done right and fix the problem,” he said.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, January 29, 2016 9:54 AM
To: Marks, Teresa; Hanson, Andrew; Hanley, Mary; Bates, William
Cc: R6 6WQ-SG; Brown, Jamesr
Subject: FW: news update for Friday 01-29-16

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Friday, January 29, 2016 9:53 AM
To: Matt Skinner
Subject: news update for Friday 01-29-16

Good morning.

Quote for the day: "It's not the having, it's the getting." (Elizabeth Taylor)

******Gov. Mary Fallin: Science must guide response to quakes (NewsOK) http://newsok.com/gov.-mary-fallin-science-must-guide-response-to-quakes/article/5475366**

****Emergency Earthquake Funds Means More Data, Staffing For State Agencies (News9) http://www.news9.com/story/31085644/ogs-occ-share-plans-for-earthquake-research-funding**

****Panel reviews solar bill proposal; OG&E's fix may hurt customers (NewsOK) http://newsok.com/panel-reviews-solar-bill-proposal-oges-fix-may-hurt-customers/article/5475438**

****Gov. Mary Fallin dips into emergency fund for earthquake research (Tulsa World) http://www.tulsaworld.com/news/state/gov-mary-fallin-dips-into-emergency-fund-for-earthquake-research/article_3c1a2365-c592-5943-bab0-053e61112ef0.html**

****Gov. Fallin transfers $1.4 million to Corporation Commission, OGS to understand earthquakes (KFOR) http://kfor.com/2016/01/28/gov-fallin-transfers-1-4-million-to-corporation-commission-ogs-to-understand-earthquakes/**

****House speaker pushes for more up-to-date wastewater disposal tracking (KOCO) http://www.koco.com/news/House-speaker-pushes-for-more-up-to-date-wastewater-disposal-tracking/37695110**

****Treading water: Fallin releases $1.4M to help study earthquakes (Journal Record)**
http://journalrecord.com/2016/01/28/treading-water-falling-releases-1-4m-to-help-study-earthquakes-energy/

****Oklahoma Gov. Mary Fallin orders $1.4M in emergency funds for earthquake research (NewsOK) http://newsok.com/oklahoma-gov.-mary-fallin-orders-1.4m-in-emergency-funds-for-earthquake-research/article/5475308**

**** Fallin puts $1.4M toward seismic research in Okla. (Energywire)**
http://www.eenews.net/energywire/2016/01/29/stories/1060031364

ALTERNATIVE ENERGY

Oklahoma wind capacity on track to pass California for third place (NewsOK)
http://www.oklahoman.com/article/5475177?embargo_redirect=yes

Point of View: Clean cities coalition is an Oklahoma success story (NewsOK)
http://newsok.com/point-of-view-clean-cities-coalition-is-an-oklahoma-success-story/article/5475362

Shell transitioning Houston truck fleet from diesel to LNG (Houston Chronicle)
http://fuelfix.com/blog/2016/01/28/shell-transitioning-houston-truck-fleet-from-diesel-to-lng/

Regulators: Rooftop solar customers keep credit (NewsOK) **http://newsok.com/regulators-rooftop-solar-customers-keep-credit/article/feed/958061**

ENERGY, ENVIRONMENT

Kansas court ponders greenhouse gas limits for coal plant (NewsOK) **http://newsok.com/kansas-court-ponders-greenhouse-gas-limits-for-coal-plant/article/feed/957561**

OF INTEREST

Moral structures: Sustainability is more than solar panels, developer says (Journal Record)
http://journalrecord.com/2016/01/28/humphreys-sustainability-is-more-than-solar-panels-real-estate/

OIL & GAS INDUSTRY

Gas blowout happened in old well regulated by old rules (NewsOK) **http://newsok.com/gas-blowout-happened-in-old-well-regulated-by-old-rules/article/feed/957988**

Harold Hamm, CEO of Oklahoma City-based Continental Resources, expects oil prices to rebound by mid-2016 (NewsOK) **http://newsok.com/harold-hamm-ceo-of-oklahoma-city-based-continental-resources-expects-oil-prices-to-rebound-by-mid-2016/article/5475462**

Rystad: $230 billion in oil projects mothballed because of cheap crude (Houston Chronicle)
http://fuelfix.com/blog/2016/01/28/rystad-230-billion-in-oil-projects-mothballed-because-of-cheap-crude/#26612101=0

Oil industry throws support behind energy reform bill (Houston Chronicle)
http://fuelfix.com/blog/2016/01/28/oil-industry-throws-support-behind-energy-reform-bill/

UTILITIES

CenterPoint buys Continuum Energy's retail business (Houston Chronicle)
http://fuelfix.com/blog/2016/01/29/centerpoint-buys-continuum-energys-retail-business/

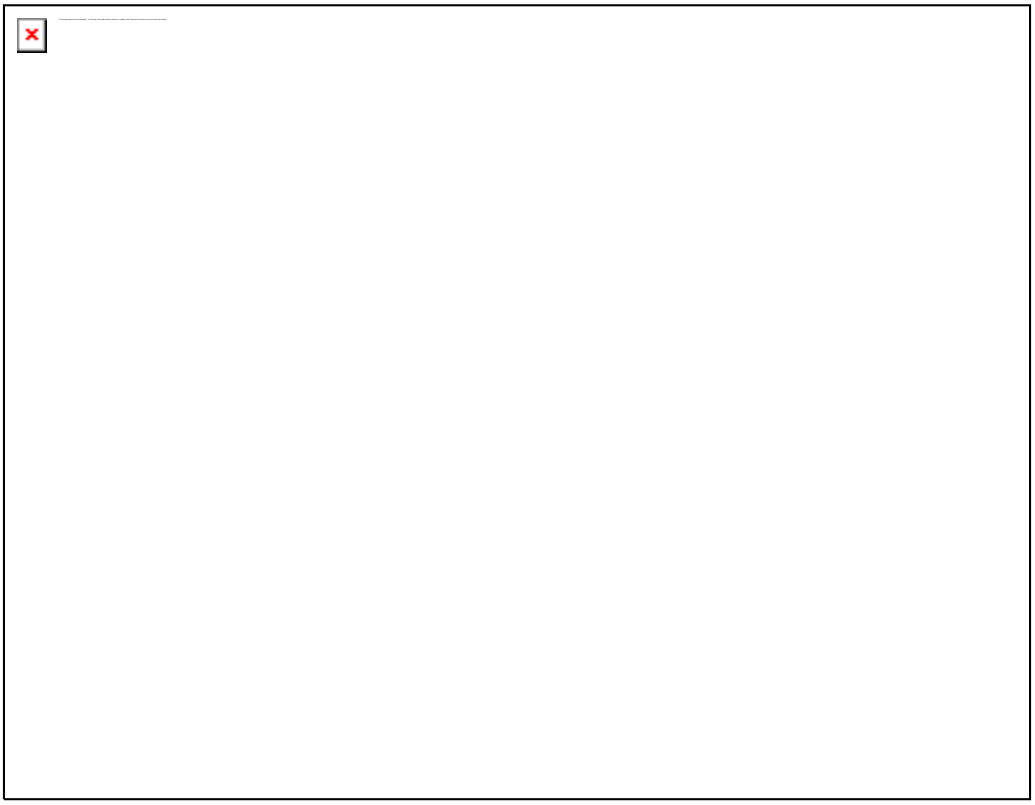
Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, January 25, 2016 11:08 AM
To: Dellinger, Philip; Brown, Jamesr
Cc: Lawrence, Rob
Subject: FW: news update for Monday 01-25-16 (includes previous)
Attachments: removed.txt

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Monday, January 25, 2016 10:24 AM
To: Matt Skinner
Subject: news update for Monday 01-25-16 (includes previous)

Good morning.

Quote for the day:



****Science needs to prevail in approach to Oklahoma quakes (NewsOK) http://newsok.com/science-needs-to-prevail-in-approach-to-oklahoma-quakes/article/5473513**

****Tulsa World Editorial: State can, should find solution to the epidemic of earthquakes without destroing the petroleum industry (Tulsa World)**

http://www.tulsaworld.com/opinion/editorials/tulsa-world-editorial-state-can-should-find-solution-to-the/article_40c4e04b-f53d-5e0a-92ee-68969d1ac2bb.html

**SandRidge, Oklahoma Corporation Commission reach settlement on disposal wells (NewsOK)
http://newsok.com/sandridge-oklahoma-corporation-commission-reach-settlement-on-disposal-wells/article/5473725

**Sandridge Energy Agrees to Shut Several Oklahoma Wells (Wall Street Journal)
http://www.wsj.com/articles/sandridge-energy-agrees-to-shut-several-oklahoma-wells-1453334751

**Moving together: SandRidge, Corporation Commission agree on plan for disposal wells (Journal Record)
http://journalrecord.com/2016/01/20/moving-together-sandridge-corporation-commission-agree-on-plan-for-disposal-wells-energy/

SandRidge agrees to shutter some Okla. disposal wells (Energywire)
http://www.eenews.net/energywire/2016/01/21/stories/1060030940

Sandridge Energy giving five wells to OGS for research (KFOR)
http://kfor.com/2016/01/20/sandridge-energy-giving-five-wells-to-ogs-for-research-2/

**Oklahoma earthquakes open opportunity for manufacturer in Coalgate (NewsOK)
http://newsok.com/oklahoma-earthquakes-open-opportunity-for-manufacturer-in-coalgate/article/5474018

**Customers have little access to Oklahoma Natural Gas information (NewsOK)
http://newsok.com/article/5473581

**Sales Tax Break Authored by Senate President Benefits His Employer (Oklahoma Watch)
http://oklahomawatch.org/2016/01/21/sales-tax-break-authored-by-senate-president-benefits-his-employer/

**Cost of doing business: Lawmaker proposes fees for wastewater disposal (Journal Record)
http://journalrecord.com/2016/01/15/cost-of-doing-business-lawmaker-proposes-fees-for-wastewater-disposal-energy/

EARTHQUAKES
Are Oklahoma buildings, bridges on shaky ground when it comes to earthquakes (NewsOK)
http://www.oklahoman.com/article/5474439?embargo_redirect=yes

OIL AND GAS INDUSTRY
Amid tough news, some see better days for shale (NewsOK) http://newsok.com/amid-tough-news-some-see-better-days-for-shale/article/5473967

Marginal wells could lose tax exemption (Journal Record)
http://journalrecord.com/2016/01/18/marginal-wells-could-lose-tax-exemption-energy/

Oil, Stocks at Tightest Correlation in 26 Years (Wall Street Journal) http://www.wsj.com/articles/oil-stocks-dance-the-bear-market-tango-1453722783

Canada's Carbon Cap May Crimp Oil Giants' New Reserves (Wall Street Journal)
http://www.wsj.com/articles/canadas-carbon-cap-may-crimp-oil-giants-new-reserves-1453667940

Williams Cuts Spending Plan (Barrons)
http://blogs.barrons.com/incomeinvesting/2016/01/25/williams-cuts-spending-plan-maintains-dividend-shares-rally/

ENERGY, ENVIRONMENT
Court rejects Oklahoma's effort to stay Clean Power Plan (NewsOK) **http://newsok.com/court-rejects-oklahomas-effort-to-stay-clean-power-plan/article/5474024**

U.S. grid monitor couples warnings with upbeat tone (Energywire)
http://www.eenews.net/energywire/2016/01/21/stories/1060030937

FERC
FERC's 'Demand Response' Rule Upheld by U.S. Supreme Court (Bloomberg)
http://www.bloomberg.com/politics/articles/2016-01-25/ferc-s-demand-response-rule-upheld-by-u-s-supreme-court

Grid overseers OK tweaks to 'remarkably vague' cyber rules (Energywire)
http://www.eenews.net/energywire/2016/01/22/stories/1060031021

GOP energy commissioner to step down this month (The Hill) **http://thehill.com/policy/energy-environment/256074-gop-energy-commissioner-to-step-down-this-month**

OF INTEREST
Lower oil prices expected to cut credit ratings for states (Journal Record)
http://journalrecord.com/2016/01/21/lower-oil-prices-expected-to-cut-credit-ratings-for-states-energy/

Terrorism takes the wheel in Texas oil regulator race (Energywire)
http://www.eenews.net/energywire/2016/01/22/stories/1060031002

Uber will keep running helicopter flights at the Sundance Film Festival despite orders to stop (AP) **http://www.businessinsider.com/uber-to-continue-helicopter-flights-at-sundance-despite-cease-and-desist-order-2016-1**

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, January 22, 2016 10:38 AM
To: Charles Lord; Patricia Downey; Tim Baker; Matt Skinner
Subject: AAPG induced seismicity articles

There was a session on Induced Seismicity at the AAPG conference this year. The Datapages (for members) just released a whole series of articles from the meeting.

- Findings and Update on the National Research Council's Committee on Induced Seismicity Potential of Energy Production and Related Technologies: David K. Dillon and Don Clarke, #70194 (2015).
- Challenges and Strategies for Monitoring Induced Seismic Activity: Dario Baturan, Wesley Greig, and Neil Spriggs, #70193 (2015).
- Recent Earthquakes in Oklahoma and the Mid-Continent: Significance and Potential for Induced Seismicity: Austin Holland, #41619 (2015).
- Seismicity Rates in Oklahoma: A Look at the Seismicity Increase of 2014: Amberlee Darold and Austin Holland, #80498 (2015).
- Oklahoma stress map for induced seismicity mitigation: Richard C. Alt and Mark D. Zoback, #70198 (2015).
- Relationships between Pre-Existing Structure, Regional Stress Orientation, and Seismicity Induced by Wastewater Injection, Northern Appalachian Basin, USA: James Free, Brian S. Currie, Robert J. Skoumal, and Michael R. Brudzinski, #41700 (2015).
- Understanding the Correlation between Induced Seismicity and Water Injection in the Fort Worth Basin: Valerie Gono, Jon E. Olson, and Julia Gale, #80481 (2015).
- Potential Induced Seismicity in the Midcontinent: One State's Experience and Response: Rex Buchanan, #70195 (2015).
- Induced Seismicity Indicated by Cross Correlation: Ivo Oprsal and Leo Eisner, #41318 (2014).
- Adaptive Control of Subsurface Fractures and Fluid Flow: A New U.S. Department of Energy Subsurface Technology and Engineering Research, Development and Demonstration Crosscut Initiative: Douglas W. Hollett and Julio Friedmann, #70183 (2015).
- Induced Seismicity in Oil and Gas Operations: Recent Activity, Monitoring and Regulations: AJulie Shemeta, #41701 (2015).
- Reservoir Induced Seismicity near Heron and El Vado Reservoirs, Northern New Mexico, and Implications for Fluid Injection within the San Juan Basin: Philip J. Carpenter and Issa W. El-Hussain, #80480 (2015).

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, January 22, 2016 10:36 AM
To: R6 6WQ-SG; Bates, William; Hildebrandt, Kurt
Subject: AAPG induced seismicity articles

There was a session on Induced Seismicity at the AAPG conference this year. The Datapages (for members) just released a whole series of articles from the meeting.

- Findings and Update on the National Research Council's Committee on Induced Seismicity Potential of Energy Production and Related Technologies: David K. Dillon and Don Clarke, #70194 (2015).
- Challenges and Strategies for Monitoring Induced Seismic Activity: Dario Baturan, Wesley Greig, and Neil Spriggs, #70193 (2015).
- Recent Earthquakes in Oklahoma and the Mid-Continent: Significance and Potential for Induced Seismicity: Austin Holland, #41619 (2015).
- Seismicity Rates in Oklahoma: A Look at the Seismicity Increase of 2014: Amberlee Darold and Austin Holland, #80498 (2015).
- Oklahoma stress map for induced seismicity mitigation: Richard C. Alt and Mark D. Zoback, #70198 (2015).
- Relationships between Pre-Existing Structure, Regional Stress Orientation, and Seismicity Induced by Wastewater Injection, Northern Appalachian Basin, USA: James Free, Brian S. Currie, Robert J. Skoumal, and Michael R. Brudzinski, #41700 (2015).
- Understanding the Correlation between Induced Seismicity and Water Injection in the Fort Worth Basin: Valerie Gono, Jon E. Olson, and Julia Gale, #80481 (2015).
- Potential Induced Seismicity in the Midcontinent: One State's Experience and Response: Rex Buchanan, #70195 (2015).
- Induced Seismicity Indicated by Cross Correlation: Ivo Oprsal and Leo Eisner, #41318 (2014).
- Adaptive Control of Subsurface Fractures and Fluid Flow: A New U.S. Department of Energy Subsurface Technology and Engineering Research, Development and Demonstration Crosscut Initiative: Douglas W. Hollett and Julio Friedmann, #70183 (2015).
- Induced Seismicity in Oil and Gas Operations: Recent Activity, Monitoring and Regulations: AJulie Shemeta, #41701 (2015).
- Reservoir Induced Seismicity near Heron and El Vado Reservoirs, Northern New Mexico, and Implications for Fluid Injection within the San Juan Basin: Philip J. Carpenter and Issa W. El-Hussain, #80480 (2015).

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, January 20, 2016 3:22 PM
To: Dellinger, Philip; Gillespie, David; Moore, Jessica
Cc: Lawrence, Rob; Bates, William; Hildebrandt, Kurt
Subject: Sandridge resolution
Attachments: 01-20-16SANDRIDGE PROJECT.pdf

Hot off the press!

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, January 20, 2016 3:21 PM
To: 'Matt Skinner'
Subject: RE: news update for Thurs 01-14-15 (includes previous)

Thanks!

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Wednesday, January 20, 2016 2:54 PM
To: Dorsey, Nancy
Subject: FW: news update for Thurs 01-14-15 (includes previous)

****Oklahoma assistant AG, Owasso resident criticize PSO's smart meter opt-out plan (NewsOK)** http://newsok.com/oklahoma-assistant-ag-owasso-resident-criticize-psos-smart-meter-opt-out-plan/article/5472363

**** Is bribery "repugnant" to the Oklahoma constitution? (KFOR)** http://kfor.com/2016/01/14/is-bribery-repugnant-to-the-oklahoma-constitution/

****Corporation Commission directs changes at 27 disposal wells near Fairview (Journal Record)** http://journalrecord.com/2016/01/13/corporation-commission-directs-changes-at-27-disposal-wells-near-fairview-energy/

****Data deluge: Corporation Commission says it's drowning in disposal well data (Journal Record)** http://journalrecord.com/2016/01/12/data-deluge-corporation-commission-says-its-drowning-in-disposal-well-data-energ/

****Broader view: Southside OKC lawmaker makes noise about earthquakes (Journal Record)** http://journalrecord.com/2016/01/12/broader-view-southside-okc-lawmaker-makes-noise-about-earthquakes-capitol/

**** Scientists: Cutting wastewater disposal to 2012 level might end quakes (Journal Record)**
http://journalrecord.com/2016/01/08/scientists-cutting-disposal-to-2012-level-might-end-quakes-energy/

EARTHQUAKES
Logan County residents sue drillers over earthquake damage (Journal Record)
http://journalrecord.com/2016/01/13/logan-county-residents-sue-drillers-over-earthquake-damage-energy/

New Oklahoma Earthquake parody (KFOR) http://kfor.com/2016/01/13/group-creates-funny-parody-about-oklahoma-earthquakes-to-taylor-swift-song/

OIL AND GAS INDUSTRY
SandRidge cuts 226 jobs at oilfield services company (NewsOK) http://newsok.com/sandridge-cuts-226-jobs-at-oilfield-services-company/article/5472304

Firefighters extinguish damaging Grady Co. fracking fire (KFOR)
http://kfor.com/2016/01/13/all-lanes-of-traffic-shut-down-due-to-large-oil-rig-fire/

Continental Resources CEO sees oil rising to $60 by year end (AP)
http://www.kansascity.com/news/business/national-international/article54541545.html

Oklahoma's energy industry continues to suffer, according to Fed survey (NewsOK)
http://newsok.com/oklahomas-energy-industry-continues-to-suffer-according-to-fed-survey/article/5471501

Regulators to give written reason for cutting oilfield fines (AP)
http://www.sunherald.com/news/business/article54107970.html

Experts to study food safety of oilfield wastewater (AP)
http://www.montereyherald.com/article/zz/20160112/NEWS/160118858

LEGISLATURE
Lawmakers' bills include fines for students who misbehave, electromagnetic pulse attacks (Tulsa World) http://www.tulsaworld.com/news/capitol_report/lawmakers-bills-include-fines-for-students-who-misbehave-electromagnetic-pulse/article_f943d672-04cf-5c42-a07d-880cdf945a16.html

ALTERNATIVE ENERGY
Ruling is another setback to proposed Iowa wind energy line (AP)
http://www.washingtontimes.com/news/2016/jan/12/ruling-is-another-setback-to-proposed-iowa-wind-en/

ELECTRIC GENERATION/TRANSMISSION
Hunt's Proposed Utility Takeover Rattles Texas Regulators (WSJ)
http://www.wsj.com/articles/hunts-proposed-utility-takeover-rattles-texas-regulators-1452721022

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, January 13, 2016 12:33 PM
To: R6 6WQ-SG; Brown, Jamesr; Hildebrandt, Kurt; Bates, William; Kobelski, Bruce
Cc: Gillespie, David; Lawrence, Rob
Subject: FW: OCC Fairview EQ advisory - final version
Attachments: 01-13-16ADVISORY.pdf

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Wednesday, January 13, 2016 12:05 PM
To: Dorsey, Nancy
Subject: FW: advisory

From: Matt Skinner
Sent: Wednesday, January 13, 2016 12:05 PM
To: 'Jason.Murphey@okhouse.gov'; 'Cory T. Williams'; 'Cory T. Williams'
Subject: advisory

attached

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, January 07, 2016 4:09 PM
To: Moore, Jessica; Gillespie, David
Subject: FW: news update for Tues 12-21-15 re Sandridge

This may help

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Tuesday, December 22, 2015 10:16 AM
To: Matt Skinner
Subject: news update for Tues 12-21-15

Good morning.

Quote for the day: "The single biggest problem in communication is the illusion that it has taken place." (George Bernard Shaw)

**** SandRidge defies Okla. directive to close 6 wells (Energywire)**
http://www.eenews.net/energywire/2015/12/21/stories/1060029814

**** SandRidge Energy balks at earthquake-related shutdown directive (Tulsa World)**
http://www.tulsaworld.com/news/government/sandridge-energy-balks-at-earthquake-related-shutdown-directive/article_41e5d28d-4102-5656-a65b-d76cc21d3721.html

**** SandRidge refuses to shut down disposal wells after quakes (NewsOK)**
http://newsok.com/sandridge-refuses-to-shut-down-disposal-wells-after-quakes/article/5468098

**** OK Corporation Commission To Take On SandRidge Energy (KWTV)**
http://www.news9.com/story/30804157/ok-corporation-commission-to-take-on-sandridge-energy

**** Oklahoma vs. Sandridge Energy: State plans legal action after company refused to shut down 6 wells (KFOR)** **http://kfor.com/2015/12/21/oklahoma-vs-sandridge-energy-state-plans-legal-action-after-company-refused-to-shut-down-6-wells/**

**** Commission preparing disposal well case against Sandridge (KOCO)**
http://www.koco.com/news/Commission-preparing-disposal-well-case-against-Sandridge/37074212

**** Oklahoma Corporation Commission preparing court action against SandRidge Energy (Fox 25)**
http://okcfox.com/news/local/corporation-commission-preparing-court-action-against-sandridge-energy

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, December 30, 2015 10:54 AM
To: Dellinger, Philip; Lawrence, Rob; Bates, William; Hildebrandt, Kurt
Subject: FW: news update for Wed 12-30-15 (includes previous)
Attachments: 12-25-15WSJ-Energy Companies Gird for Weaker Prices in 2016.doc; 12-20-15WSJ-Biofuels Move From Lab to Frying Pan.doc; 12-29-15WSJ-No Pressure Release for Natural Gas.doc; 12-30-15JR-Shifting the debate-Edmond quake could bring policy decision home to leaders.doc; 12-30-15JR-Blowing up-Wind power grew in 2015, experts expect more in 2016.doc; 12-28-15JR - Standing their ground.doc

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From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Wednesday, December 30, 2015 10:35 AM
To: Matt Skinner
Subject: news update for Wed 12-30-15 (includes previous)

Good morning.

Quote for the day: "Youth is when you're allowed to stay up late on New Year's Eve. Middle age is when you're forced to." (Bill Vaughn)

** Oklahoma lawmakers say state needs stronger regulation after Edmond quakes (Fox 25) http://okcfox.com/news/local/oklahoma-lawmakers-say-state-needs-stronger-regulation-after-edmond-quakes

**After earthquakes shake Edmond area, Oklahoma regulators prepare response (NewsOK) http://newsok.com/after-earthquakes-shake-edmond-area-oklahoma-regulators-prepare-response/article/5469411

** Shifting the debate: Edmond quake could bring policy decision home to leaders (Journal Record) http://journalrecord.com/2015/12/29/shifting-the-debate-edmond-quake-could-bring-policy-decision-home-to-leaders-capitol/

** 4.3-magnitude earthquake rattles central Oklahoma (AP) http://news.yahoo.com/strong-earthquake-rattles-central-oklahoma-142109871.html;_ylt=A0LEVr7D34NWl0kAp3RjmolQ

** Edmond Residents Dealing With Damage After 4.3 Earthquake (KWTV) http://www.news9.com/story/30849588/edmond-residents-dealing-with-damage-after-43-earthquake

** It was just a loud, massive crash," Edmond residents clean up damage after Tuesday morning earthquake (KFOR) http://kfor.com/2015/12/29/it-was-just-a-loud-massive-crash-edmond-residents-clean-up-damage-after-tuesday-morning-earthquake/

**SandRidge still operating wells after OCC requests shutdown (Enid News) http://www.enidnews.com/news/local_news/sandridge-still-operating-wells-after-occ-requests-shutdown/article_9a15cba6-f9f4-5f4b-9780-9b0532508fc4.html

**Standing their ground: Why is SandRidge fighting OCC requests on disposal wells? (Journal Record)

http://journalrecord.com/2015/12/24/standing-their-ground-why-is-sandridge-fighting-occ-requests-on-disposal-wells-energy/

OIL AND GAS INDUSTRY

Saudi Arabia says won't limit oil production, can meet customer demand (Reuters)
http://www.marketwatch.com/story/saudi-arabia-says-its-ready-to-meet-any-additional-oil-demand-2015-12-30

Energy Companies Gird for Weaker Prices in 2016 (Wall Street Journal)
http://www.wsj.com/articles/energy-companies-gird-for-weaker-prices-in-2016-1451039405?tesla=y

No Pressure Release for Natural Gas (Wall Street Journal) http://www.wsj.com/articles/no-pressure-release-for-natural-gas-1451410336

ALTERNATIVE ENERGY

Blowing up: Wind power grew in 2015, experts expect more in 2016 (Journal Record)
http://journalrecord.com/2015/12/29/blowing-up-wind-power-grew-in-2015-experts-expect-more-in-2016-energy/

Renewable energy efforts stymied by transmission roadblocks (AP)
http://bigstory.ap.org/article/0462fcffedd749c2a7e0e729be79d681/renewable-energy-efforts-stymied-transmission-roadblocks

Biofuels Move From Lab to Frying Pan (Wall Street Journal)
http://www.wsj.com/articles/biofuels-move-from-lab-to-frying-pan-1450660360

ELECTRIC GENERATION AND TRANSMISSION

Extreme weather poses increasing threat to US power grid (AP)
http://bigstory.ap.org/article/843e1c7d1fdd494fb73bdfda47283fc9/extreme-weather-poses-increasing-threat-us-power-grid

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, December 30, 2015 10:47 AM
To: 'Matt Skinner'
Subject: RE: news update for Wed 12-30-15 (includes previous)

Thanks! I love your quotes, too. ☺

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Wednesday, December 30, 2015 10:35 AM
To: Matt Skinner
Subject: news update for Wed 12-30-15 (includes previous)

Good morning.

Quote for the day: "Youth is when you're allowed to stay up late on New Year's Eve. Middle age is when you're forced to." (Bill Vaughn)

** Oklahoma lawmakers say state needs stronger regulation after Edmond quakes (Fox 25) http://okcfox.com/news/local/oklahoma-lawmakers-say-state-needs-stronger-regulation-after-edmond-quakes

**After earthquakes shake Edmond area, Oklahoma regulators prepare response (NewsOK) http://newsok.com/after-earthquakes-shake-edmond-area-oklahoma-regulators-prepare-response/article/5469411

** Shifting the debate: Edmond quake could bring policy decision home to leaders (Journal Record) http://journalrecord.com/2015/12/29/shifting-the-debate-edmond-quake-could-bring-policy-decision-home-to-leaders-capitol/

** 4.3-magnitude earthquake rattles central Oklahoma (AP) http://news.yahoo.com/strong-earthquake-rattles-central-oklahoma-142109871.html;_ylt=A0LEVr7D34NWl0kAp3RjmolQ

** Edmond Residents Dealing With Damage After 4.3 Earthquake (KWTV) http://www.news9.com/story/30849588/edmond-residents-dealing-with-damage-after-43-earthquake

** It was just a loud, massive crash," Edmond residents clean up damage after Tuesday morning earthquake (KFOR) http://kfor.com/2015/12/29/it-was-just-a-loud-massive-crash-edmond-residents-clean-up-damage-after-tuesday-morning-earthquake/

**SandRidge still operating wells after OCC requests shutdown (Enid News) http://www.enidnews.com/news/local_news/sandridge-still-operating-wells-after-occ-requests-shutdown/article_9a15cba6-f9f4-5f4b-9780-9b0532508fc4.html

**Standing their ground: Why is SandRidge fighting OCC requests on disposal wells? (Journal Record) http://journalrecord.com/2015/12/24/standing-their-ground-why-is-sandridge-fighting-occ-requests-on-disposal-wells-energy/

OIL AND GAS INDUSTRY

Saudi Arabia says won't limit oil production, can meet customer demand (Reuters)
http://www.marketwatch.com/story/saudi-arabia-says-its-ready-to-meet-any-additional-oil-demand-2015-12-30

Energy Companies Gird for Weaker Prices in 2016 (Wall Street Journal)
http://www.wsj.com/articles/energy-companies-gird-for-weaker-prices-in-2016-1451039405?tesla=y

No Pressure Release for Natural Gas (Wall Street Journal) http://www.wsj.com/articles/no-pressure-release-for-natural-gas-1451410336

ALTERNATIVE ENERGY

Blowing up: Wind power grew in 2015, experts expect more in 2016 (Journal Record)
http://journalrecord.com/2015/12/29/blowing-up-wind-power-grew-in-2015-experts-expect-more-in-2016-energy/

Renewable energy efforts stymied by transmission roadblocks (AP)
http://bigstory.ap.org/article/0462fcffedd749c2a7e0e729be79d681/renewable-energy-efforts-stymied-transmission-roadblocks

Biofuels Move From Lab to Frying Pan (Wall Street Journal)
http://www.wsj.com/articles/biofuels-move-from-lab-to-frying-pan-1450660360

ELECTRIC GENERATION AND TRANSMISSION

Extreme weather poses increasing threat to US power grid (AP)
http://bigstory.ap.org/article/843e1c7d1fdd494fb73bdfda47283fc9/extreme-weather-poses-increasing-threat-us-power-grid

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, December 29, 2015 8:32 AM
To: R6 6WQ-SG; Brown, Jamesr; Honker, William; Lawrence, Rob
Subject: M4.3 brings power outages

1. **Oklahoma earthquake blamed for thousands of power outages**
   NWA Online · 2 minutes ago
   EDMOND, Okla. — A strong **earthquake** awoke many people in the **Oklahoma** City area early Tuesday. There are no immediate reports of …
   4.3 Magnitude Earthquake Causes Damage, Power Outage Near Edmond
   Oklahoma's Own NewsOn6 · 30 minutes ago
   The U.S. Geological Survey reported a 4.3 magnitude **earthquake** centered near Edmond, **Oklahoma**. This **earthquake** was recorded at 5:39 …
   Strong Earthquake Hits Oklahoma
   KSCB News · 5 minutes ago
   A strong **earthquake** awoke many people in the **Oklahoma** City area early Tuesday. There are no immediate reports of major damage, but the …

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, December 16, 2015 1:19 PM
To: Dellinger, Philip; Brown, Jamesr
Subject: FW: news update for Wed 12-16-15

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Wednesday, December 16, 2015 9:24 AM
To: Matt Skinner
Subject: news update for Wed 12-16-15

Good morning.

Quote for the day: "You should always forgive your enemies. You never know when you'll be forced to work with them." (Lana Turner)

OF INTEREST

State agencies told to brace for revenue failure as $900 million budget hole expected next year (NewsOK) http://www.tulsaworld.com/news/capitol_report/state-agencies-told-to-brace-for-revenue-failure-as-million/article_b3c4bc20-9b17-59c4-8ebb-bd074d4d45d8.html

Oklahoma state budget woes highlight need to reform process (NewsOK)
http://newsok.com/oklahoma-state-budget-woes-highlight-need-to-reform-process/article/5466220

OIL AND GAS INDUSTRY

The Global Battle for Oil Market Share (Wall Street Journal) http://www.wsj.com/articles/the-global-battle-for-oil-market-share-1450220940

Congress Reaches Fiscal Agreement Ending U.S. Oil Export Ban (Bloomberg)
http://www.bloomberg.com/politics/articles/2015-12-16/congress-reaches-fiscal-deal-that-ends-u-s-crude-oil-export-ban

Moves by OPEC ministers weigh on Oklahoma oil patch (NewsOK) http://newsok.com/moves-by-opec-ministers-weigh-on-oklahoma-oil-patch/article/5466221

Halliburton bid for Baker Hughes in limbo as deadline looms (Bloomberg)
http://www.tulsaworld.com/washingtonpost/business/halliburton-bid-for-baker-hughes-in-limbo-as-deadline-looms/article_1ab6a822-f03e-56a3-a5c9-d9b525c48734.html

Banks Bet on Energy Comeback (Wall Street Journal) http://www.wsj.com/articles/banks-to-energy-companies-hang-in-there-1450261802

Saudi Arabia Spends Billions to Get Asia Hooked on Its Crude Oil (Bloomberg)
http://www.bloomberg.com/news/articles/2015-12-16/saudi-arabia-spends-billions-to-get-asia-hooked-on-its-crude-oil

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, December 11, 2015 8:29 AM
To: Tim Baker; Charles Lord; Patricia Downey
Subject: FW: tough times in oilfield article

Sandridge is prominently featured in the article below.

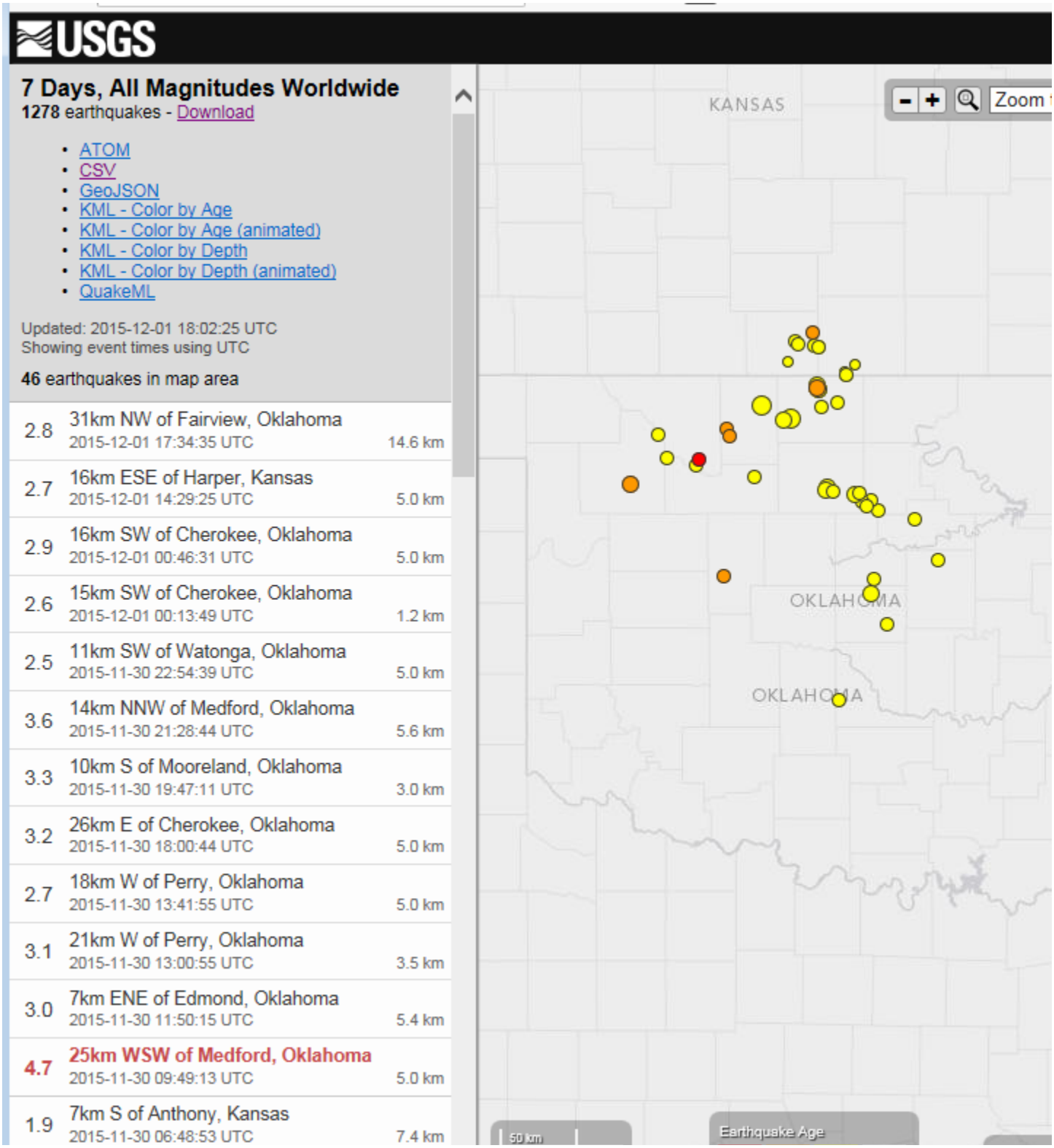
From: Johnson, Ken-E
Sent: Thursday, December 10, 2015 1:46 PM
To: R6 6WQ-SG
Subject: tough times in oilfield article

http://www.reuters.com/article/us-oil-usa-zombies-insight-idUSKBN0TT0FA20151210

Ken Johnson, P.E.
Environmental Engineer
EPA R6 Ground Water/UIC Section
Mail Code 6WQ-SG
Suite 1200
1445 Ross Avenue
Dallas, Texas 75202
Johnson.ken-e@epa.gov
214-665-8473
972-754-4991 (cell)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, December 01, 2015 12:40 PM
To: Brown, Jamesr; Dellinger, Philip
Subject: RE: OK Earthquakes Update - include 7 day plot?



From: Brown, Jamesr
Sent: Tuesday, December 01, 2015 11:46 AM
To: Dorsey, Nancy; Dellinger, Philip
Subject: FW: OK Earthquakes Update

James R. Brown, P.G.
Associate Director
Safe Drinking Water Branch
Water Division
U.S. EPA Region 6
1445 Ross Avenue (Mail Code: 6WQ-S)
Dallas, Texas 75202-2733
Phone: (214) 665-3175

http://www.epa.gov/region6/water/index.htm

From: Honker, William
Sent: Tuesday, December 01, 2015 8:56 AM
To: Brown, Jamesr; Dellinger, Philip
Cc: Garcia, David
Subject: OK Earthquakes Update

Jim/Phil – since Ron is going to OK tomorrow, could you send me a brief update today on the recent flurry of earthquakes in OK? Doesn't need to be in fact sheet form, bullets are fine.

Thanks.

Bill

William K. Honker, P.E.
Director, Water Division (6WQ)
EPA Region 6
Dallas, TX
214-665-3187
http://www.epa.gov/region6/water/index.htm

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, November 30, 2015 9:07 AM
To: Lawrence, Rob
Subject: RE: 2015-11-30 09:49:13 (M4.5) OKLAHOMA 36.7 -98.0 (63093) - Medford today

Actually, that was from last week.

From: Lawrence, Rob
Sent: Monday, November 30, 2015 9:05 AM
To: Graves, Brian; Bates, William; Kobelski, Bruce; Hildebrandt, Kurt
Cc: Overbay, Michael; Dorsey, Nancy; Dellinger, Philip
Subject: RE: 2015-11-30 09:49:13 (M4.5) OKLAHOMA 36.7 -98.0 (63093) - Medford today

Interesting article on NPR this morning from State Impact Oklahoma regarding concerns in Cushing.

https://stateimpact.npr.org/oklahoma/2015/11/24/oil-company-makes-new-earthquake-plans-after-shaking-near-u-s-storage-hub-in-oklahoma/

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Graves, Brian
Sent: Monday, November 30, 2015 8:44 AM
To: Bates, William; Lawrence, Rob; Kobelski, Bruce; Hildebrandt, Kurt
Subject: FW: 2015-11-30 09:49:13 (M4.5) OKLAHOMA 36.7 -98.0 (63093) - Medford today

And so it continues.

From: Dorsey, Nancy
Sent: Monday, November 30, 2015 8:43 AM
To: R6 6WQ-SG
Cc: Brown, Jamesr
Subject: FW: 2015-11-30 09:49:13 (M4.5) OKLAHOMA 36.7 -98.0 (63093) - Medford today

---

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Monday, November 30, 2015 4:09 AM
To: Dorsey, Nancy
Subject: 2015-11-30 09:49:13 (M4.5) OKLAHOMA 36.7 -98.0 (63093)

M4.5 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.5
Date-Time	30 Nov 2015 09:49:13 UTC 30 Nov 2015 03:49:14 near epicenter 30 Nov 2015 02:49:13 standard time in your timezone
Location	36.746N 98.015W
Depth	5 km
Distances	26 km (16 mi) WSW of Medford, Oklahoma 40 km (24 mi) NNW of Enid, Oklahoma 83 km (51 mi) W of Ponca City, Oklahoma 93 km (57 mi) WSW of Arkansas City, Kansas 148 km (91 mi) NNW of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 2.3 km; Vertical 2.0 km
Parameters	Nph = 57; Dmin = 18.5 km; Rmss = 0.57 seconds; Gp = 105° Version =
Event ID	us 1000424d

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

Disclaimer

This email was sent to dorsey.nancy@epa.gov

You requested mail for events within the 'R6 plus CO' region
for M1.0 between 08:00 and 20:00 and M1.5 other times.

To change your parameters, go to:

https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, November 30, 2015 8:43 AM
To: R6 6WQ-SG
Cc: Brown, Jamesr
Subject: FW: 2015-11-30 09:49:13 (M4.5) OKLAHOMA 36.7 -98.0 (63093) - Medford today

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Monday, November 30, 2015 4:09 AM
To: Dorsey, Nancy
Subject: 2015-11-30 09:49:13 (M4.5) OKLAHOMA 36.7 -98.0 (63093)

M4.5 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.5
Date-Time	30 Nov 2015 09:49:13 UTC 30 Nov 2015 03:49:14 near epicenter 30 Nov 2015 02:49:13 standard time in your timezone
Location	36.746N 98.015W
Depth	5 km
Distances	26 km (16 mi) WSW of Medford, Oklahoma 40 km (24 mi) NNW of Enid, Oklahoma 83 km (51 mi) W of Ponca City, Oklahoma 93 km (57 mi) WSW of Arkansas City, Kansas 148 km (91 mi) NNW of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 2.3 km; Vertical 2.0 km
Parameters	Nph = 57; Dmin = 18.5 km; Rmss = 0.57 seconds; Gp = 105° Version =
Event ID	us 1000424d

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

Disclaimer

This email was sent to dorsey.nancy@epa.gov

You requested mail for events within the 'R6 plus CO' region
for M1.0 between 08:00 and 20:00 and M1.5 other times.

To change your parameters, go to:

https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, November 20, 2015 11:48 AM
To: R6 6WQ-SG; Bates, William; Hildebrandt, Kurt; Lawrence, Rob
Cc: Brown, Jamesr
Subject: OCC earthquake actions updated on web

http://earthquakes.ok.gov/news/

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, November 20, 2015 8:47 AM
To: Dellinger, Philip
Subject: FW: Crescent leter, Map table - OCC actions
Attachments: M4.0_Crescent 11-19-15_.docx; Crescent 4.0 11-19-15_map.pdf; CHEROKEE ADVISORY.pdf

Importance: High

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Thursday, November 19, 2015 5:27 PM
To: Dorsey, Nancy
Subject: FW: Crescent leter, Map table

See attached. Cherokee is final and released. Also attached is response I was given to draft from for Crescent. Note 6-10 mile. After I spoke to Charles by phone just now, volumes may be revised (including those in 6 – 10). He will revisit tomorrow. Advisory tonight for Crescent will deal only with shut-in's, with "volume cuts being planned."

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, November 20, 2015 8:47 AM
To: 'Matt Skinner'
Subject: RE: Crescent leter, Map table

Thanks Matt!

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Thursday, November 19, 2015 5:27 PM
To: Dorsey, Nancy
Subject: FW: Crescent leter, Map table

See attached. Cherokee is final and released. Also attached is response I was given to draft from for Crescent. Note 6-10 mile. After I spoke to Charles by phone just now, volumes may be revised (including those in 6 – 10). He will revisit tomorrow. Advisory tonight for Crescent will deal only with shut-in's, with "volume cuts being planned."

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, November 17, 2015 9:54 AM
To: Lawrence, Rob; Graves, Brian; R6 6WQ-SG; Bates, William; Kobelski, Bruce; Brown, Jamesr
Cc: Hanley, Mary; Hanley, Mary; Marks, Teresa
Subject: RE: Fort Worth Star-Telegram - Lessons learned about gas well and quakes

It links to the IOGCC/GWPC report released about a month ago.

From: Lawrence, Rob
Sent: Tuesday, November 17, 2015 8:26 AM
To: Graves, Brian; R6 6WQ-SG; Bates, William; Kobelski, Bruce; Brown, Jamesr
Cc: Hanley, Mary; Hanley, Mary; Marks, Teresa
Subject: Fort Worth Star-Telegram - Lessons learned about gas well and quakes

This opinion piece ran in the Fort Worth Star-Telegram today (11/17/15)

Lessons learned about gas well and quakes

By Isaac Orr

Special to the Star-Telegram

Some people incorrectly think hydraulic fracturing — fracking — is responsible for the increase in earthquake activity in Oklahoma and Texas.

Scientists, however, believe the quakes are caused by the use of underground injection wells to dispose of oil and gas wastewater.

The increase in tremors spurred a coalition of scientists, regulators, industry experts and environmentalists to produce a 148-page report exploring why these earthquakes are occurring and how to prevent future incidents.

In the mid-1960s, earthquakes began to occur in some parts of the country that were using a technique called enhanced oil recovery, which involves pumping water into an oil formation to increase the amount of oil recovered by “flooding” the oil out of the rock.

On rare occasions, the technique caused tremors because secondary recovery operations often entailed large arrays of wells injecting fluids at high pressures into small confined reservoirs with low permeability.

Studies investigating the link between EOR and seismicity found the risk posed by induced earthquakes can be mitigated by careful control of the specific activity responsible for the induced seismicity.

Seismicity can eventually be stopped by either ceasing the injection or lowering the pumping pressures.

Similar safety procedures have been recommended for the wastewater disposal wells linked to tremors in Oklahoma and Texas.

The U.S. Geological Survey reports there are more than 35,000 injection wells used to dispose of oil and gas wastewater in the United States, and only a few dozen have been linked to any sort of felt seismic activity.

Taking precautions such as avoiding disposal near fault lines, installing pressure monitors in these wells, reducing the volume and pressures at which fluids are injected into these wells and perhaps shuttering specific wells entirely can greatly reduce the risk of additional tremors.

With scientists and engineers decades ago having figured out how to prevent earthquakes when injecting water into oil formations during enhanced oil recovery operations, one might well wonder why such earthquakes are still happening in Oklahoma and Texas.

Unsurprisingly, geology is the key factor determining why certain areas are more prone to quakes than others.

Injection wells are used at high volumes in Michigan, North Dakota and other areas yet have not resulted in any felt quakes, whereas a few wells operating under similar volumes in Oklahoma have brought an increase in tremors.

The specific factors making wastewater disposal in Oklahoma more of a risk than the same activity in North Dakota will take time to figure out, as the unique geology of each region complicates the issue and makes a “one-size-fits-all” regulatory approach a poor response.

Understanding the historical relationship between induced seismicity and oil and natural gas production is important for scientists and state regulators because it provides a road map for determining the causes of the current tremors and a toolbox of approaches to limit their occurrence in the future.

Isaac Orr (iorr@heartland.org) is a research fellow for energy and environmental policy at the Heartland Institute. @thefrackingguy

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Graves, Brian
Sent: Tuesday, November 17, 2015 6:48 AM
To: R6 6WQ-SG; Lawrence, Rob; Bates, William; Kobelski, Bruce; Brown, Jamesr
Subject: FW: 2015-11-15 22:07:51 (M2.0) NORTHERN TEXAS 32.8 -96.9 (8503a)

A small one last night ☺

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Monday, November 16, 2015 10:16 PM
To: Graves, Brian
Subject: 2015-11-15 22:07:51 (M2.0) NORTHERN TEXAS 32.8 -96.9 (8503a)

M2.0 - NORTHERN TEXAS

Preliminary Earthquake Report	
Magnitude	2.0
Date-Time	15 Nov 2015 22:07:51 UTC 15 Nov 2015 16:07:52 near epicenter 15 Nov 2015 15:07:51 standard time in your timezone
Location	32.845N 96.948W
Depth	5 km
Distances	3 km (1 mi) N of Irving, Texas 10 km (6 mi) SSW of Farmers Branch, Texas 11 km (6 mi) NNE of Grand Prairie, Texas 12 km (7 mi) E of Euless, Texas 295 km (182 mi) S of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 1.2 km; Vertical 1.4 km
Parameters	Nph = 19; Dmin = 3.2 km; Rmss = 0.38 seconds; Gp = 101° Version =
Event ID	us 10003yvs

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

Disclaimer

This email was sent to graves.brian@epa.gov

You requested mail for events within the 'Texas' region
for M2.0 at all times.

To change your parameters, go to:

https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP graves.brian@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, November 17, 2015 8:22 AM
To: Johnson, Ken-E; Overbay, Michael
Cc: Dellinger, Philip; Brown, Jamesr
Subject: Basis for the upcoming WAR, the Fairview M4
Attachments: 11-16-15FAIRVIEW and MAP.pdf

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Monday, November 16, 2015 5:07 PM
To: Craig Sundstrom; Michael Teague
Cc: Michael McNutt
Subject: FW: posting

Attached – just released

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, November 12, 2015 12:51 PM
To: Overbay, Michael
Subject: another WAR???

http://www.occeweb.com/News/11-10-15MEDFORD02.pdf update WAR?

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, November 03, 2015 8:54 AM
To: Lawrence, Rob; R6 6WQ-SG; Brown, Jamesr
Subject: FW: EARTHQUAKES: Sierra Club threatens to sue drillers to stop Okla. shaking

---

From: Hildebrandt, Kurt
Sent: Tuesday, November 03, 2015 8:45 AM
To: Graves, Brian; Dorsey, Nancy; Johnson, Ken-E; Dellinger, Philip
Subject: EARTHQUAKES: Sierra Club threatens to sue drillers to stop Okla. shaking

FYI – I'm sure you've already seen or heard about this but just in case.

EARTHQUAKES:

Sierra Club threatens to sue drillers to stop Okla. shaking

Mike Soraghan, E&E reporter

Published: Tuesday, November 3, 2015

The Sierra Club is threatening to sue four oil companies, alleging their wastewater disposal operations have caused hundreds of earthquakes in Oklahoma.

The group's call for the drillers to curtail operations is the first major move by a national environmental group in response to Oklahoma's earthquake swarms. Until now, it primarily has been local activists and a handful of people who have filed lawsuits.

"Oklahoma is literally being shaken to its core by the operations of these oil and gas companies," said Paul Bland, executive director of Public Justice, which has teamed with the Sierra Club for the legal action. "There is a clear and present danger posed by these irresponsible operations. If the energy companies do not voluntarily take action to stop it, we will take them to court."

Public Justice and the Sierra Club yesterday released a notice of intent to sue under federal environmental laws.

The letter names four companies: Chesapeake Energy Corp., Devon Energy Corp., New Dominion LLC and SandRidge Energy Inc. Chesapeake, Devon and New Dominion declined to comment. Officials with SandRidge did not respond to requests for comment.

The letter calls on the companies, which all have high-volume disposal operations in Oklahoma, to reduce the amount of waste fluid they're injecting into deep disposal wells. It also says they should reinforce vulnerable structures and establish an "independent forecasting body" to study the seismic effects of deep injection.

If the companies don't meet those demands in the next 90 days, the letter says, the Sierra Club will file a lawsuit in federal court.

The hope is that a federal judge would step in and declare moratoriums in some areas and restrict the volumes that companies can inject and the pressures they use to force the fluid down. State officials have said they lack the authority to impose a moratorium, though they've shown no desire to do so.

Putting it under a federal judge "takes the politics out of the process," said Scott Poynter, a Little Rock, Ark., lawyer who is part of the legal team pursuing the case. He is currently suing New Dominion on behalf of a woman injured in a November 2011 quake. He has also filed a class-action suit.

Oklahoma had 585 earthquakes last year of magnitude 3 or greater and has already had more than 740 such quakes this year. The Sierra Club's letter says there aren't just more of them than last year -- they're also getting bigger.

Scientists say the unprecedented swarms of man-made earthquakes are likely the result of favorably aligned faults and production methods in Oklahoma that create uniquely large volumes of wastewater. The fluid seeps into the faults, changing the pressure, and they slip.

The Sierra Club's letter says that the quakes have occurred near wells belonging to the four named companies or along faults close to the companies' wells.

Arkansas, Colorado, Texas, Ohio, New Mexico and West Virginia have also had quakes with suspected links to wastewater from oil and gas operations. Additionally, the swarm in north-central Oklahoma has pushed north into Kansas.

Scientists at the U.S. Geological Survey began warning in 2012 that a "remarkable" surge in earthquakes in Oklahoma and the middle of the country was likely linked to disposal operations.

State officials came around to that position in April after years of waffling. Elected officials are reluctant to criticize an industry that is linked to one in five jobs in the state. And some industry leaders exerted pressure on scientists when they voiced concerns that the shaking might be linked to oil operations (*EnergyWire*, June 23).

The Oklahoma Corporation Commission, which regulates oil and gas in the state, has restricted volumes and pressure in two areas in the state, including near the pipeline hub of Cushing. Before that, it focused on ensuring that wells were not drilled too deep.

A Tulsa company recently challenged OCC's authority to restrict disposal wells because of earthquakes (*EnergyWire*, Oct. 13).

Two members of the commission have questioned whether they have the legal authority to enact those restrictions. But the third commissioner, Dana Murphy, asserted last week that the commission has statutory authority for emergency response.

Poynter, though, said the question of legal authority remains.

"That is a legal question with merit to it," Poynter said.

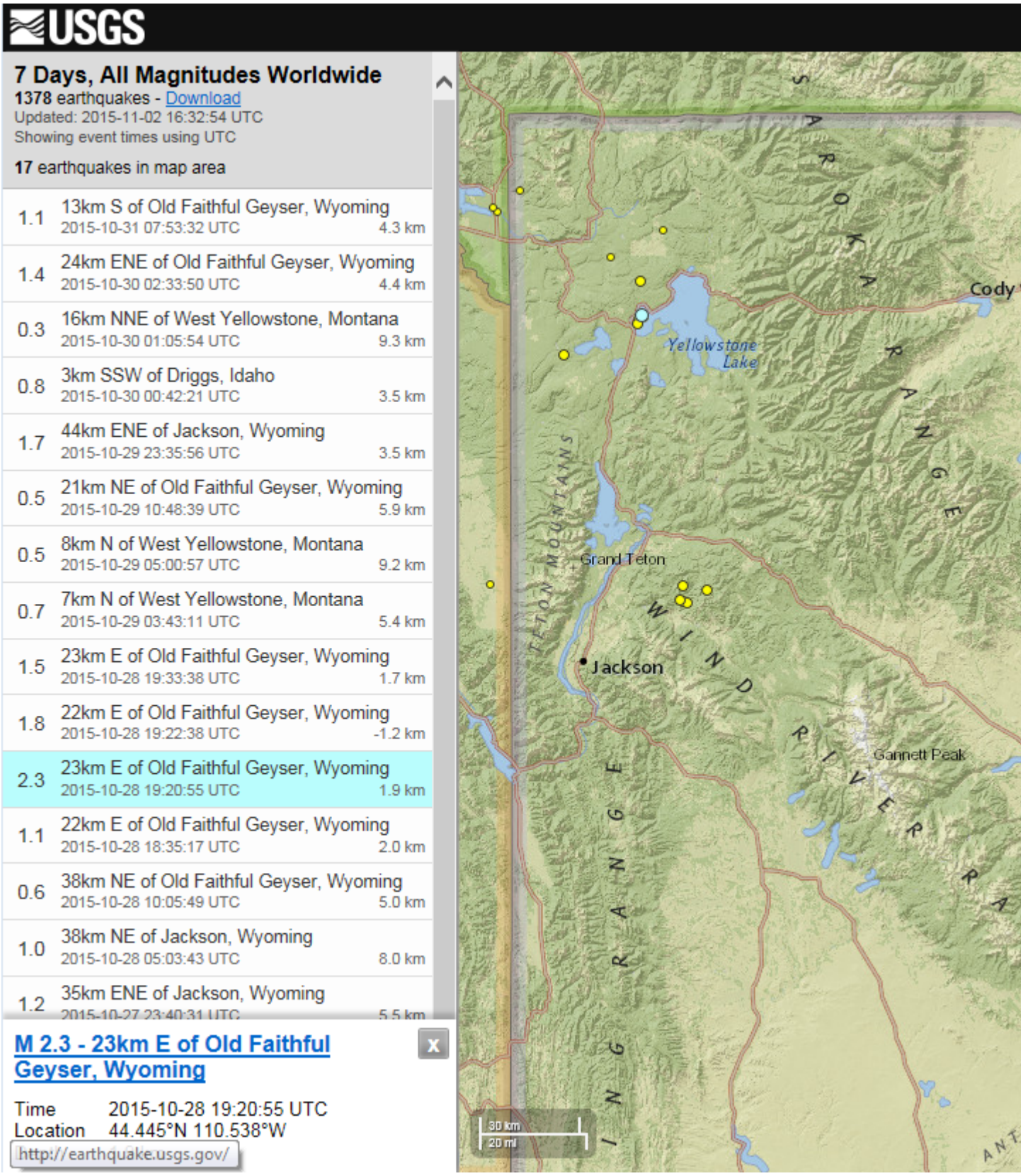
Other environmental groups have weighed in on oil and gas wastewater issues. A coalition pressed U.S. EPA for changes in August (*EnergyWire*, Aug. 27). But their effort didn't focus on earthquakes.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, November 02, 2015 10:38 AM
To: Charles Lord; Tim Baker; Matt Skinner; Patricia Downey
Subject: RE: See, Oklahoma's not so bad

http://denver.cbslocal.com/2015/10/31/huge-crack-discovered-in-earth-in-wyoming/

No seismicity recorded…but I don't know how many monitors they have. Ten Sleep is east of Worland, just before the road turns north.



From: Bierschenk, Arnold
Sent: Monday, November 02, 2015 10:24 AM
To: Dellinger, Philip; R6 6WQ-SG; Brown, Jamesr
Subject: See, Oklahoma's not so bad

Call me when this starts happening.

http://denver.cbslocal.com/2015/10/31/huge-crack-discovered-in-earth-in-wyoming/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, October 23, 2015 4:40 PM
To: R6 6WQ-SG; Lawrence, Rob; Bates, William; Hildebrandt, Kurt
Subject: AAPG Explorer article: Seismicity Events Rise in Oklahoma
Attachments: SeismicityRiseinOklahoma_Explorer.pdf

It was published October 1st. There are some great quotes!!! (see the full article)

Potential Causes

The increased activity correlates with the areas of two major oil plays, the Mississippi Lime play and the Hunton dewatering play, she said.

Darold said that about 70 percent of the wastewater is being injected into the Arbuckle, which lies directly above the basement rock.

The increased pore pressure decreases the effective stress in the basement rock and, she said, "Basically, you're pushing that fault to failure."

....

Knowledge gleaned from the Sooner state experience could prove useful elsewhere.

"Geology does not stop at the state line," she said.

The increased seismicity - and the attention it is getting - is broadening researchers' knowledge base.

"Honestly, we're learning a lot about the faults from the seismicity we are seeing," Darold said.

"It's not exactly an 'upside,' but it is showing us a lot about the faults in Oklahoma - and it's a great research playground for people all over the world."

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, October 21, 2015 2:01 PM
To: R6 6WQ-SG
Cc: Lawrence, Rob; Bates, William; Gillespie, David; Hildebrandt, Kurt
Subject: Oklahoma Geological Survey Experiencing Staff Shake-Up

Importance: High

http://www.news9.com/story/30310387/oklahoma-geological-survey-experiencing-staff-shake-up

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, October 21, 2015 9:18 AM
To: R6 6WQ-SG; Hildebrandt, Kurt; Bates, William
Subject: FW: Seismic Reg Update
Attachments: 10-15-15_KBAKIOGAAnnual.pptx

Importance: High

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Wednesday, October 21, 2015 9:05 AM
To: Bob Anthony; Dana Murphy; Jackie Hollinhead; Jordan Spencer; Joseph Briley; Joyce Boyd; Nicole King; Teryl Williams; Todd Hiett
Cc: Tim Baker; Charles Lord; Jim Marlatt
Subject: FW: Seismic Reg Update

Find attached Ryan Hoffman's (KCC Oil and Gas Director) recent presentation: Kansas Seismic Activity Update: Regulatory Actions

Matt

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, October 21, 2015 8:49 AM
To: Morris, Abigail
Subject: Will you get this article for us please?

http://bssa.geoscienceworld.org/content/early/2015/10/19/0120150109.full.pdf+html

- Susan E. Hough and
- Morgan Page

A Century of Induced Earthquakes in Oklahoma? *Bulletin of the Seismological Society of America, First published on October 20, 2015, doi:10.1785/0120150109*

Thanks!
Nancy

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, October 20, 2015 10:08 AM
To: Lawrence, Rob; Gillespie, David
Subject: Cushing articles
Attachments: The one I was looking for; more on Cushing; fyi

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, October 19, 2015 4:04 PM
To: Dellinger, Philip; Johnson, Ken-E
Subject: FW: cushing
Attachments: 10-19-15CUSHING 2.pdf

The actual press memo, plus last week's letter to operators is attached.

From: Matt Skinner [mailto:M.Skinner@occemail.com]
Sent: Monday, October 19, 2015 4:02 PM
To: Dorsey, Nancy
Subject: cushing

attached

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, October 14, 2015 9:12 AM
To: R6 6WQ-SG
Cc: Brown, Jamesr; Lawrence, Rob
Subject: Saturday 4.5 Cushing 4.8 Medford
Attachments: 2015-10-10 22:03:05 (M4.5) OKLAHOMA 36.0 -96.8 (63093); 2015-10-10 09:20:43 (M4.8) OKLAHOMA 36.7 -97.9 (63093)

4.8 downgraded to 4.4 at Medford with felt reactions indicating potential damage ‘very light’ with ‘moderate’ shaking. 4.5 at Cushing (tank farm!) listed as “Light” potential damage **with ‘strong’ shaking.**

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, October 01, 2015 8:31 AM
To: R6 6WQ-SG
Cc: Lawrence, Rob; Brown, Jamesr
Subject: FW: The primer is FINISHED..

From: Ben Grunewald [mailto:ben@gwpc.org]
Sent: Wednesday, September 30, 2015 10:20 PM
Subject: Re: The primer is FINISHED..

AP's Julie Carr Smyth's story was picked up about 129 outlets Ohio media that picked up Julie's story included: Martin's Ferry Times Leader, Lorain Morning Journal, News Herald (Lake County), Columbus Dispatch, Akron Beacon Journal, WOWK, WHIO in Dayton. Nationally, it was also picked up in: Washington Post, FOX 5 in New York, Tulsa World, Denver's ABC station and the Dallas Morning News.

States get advice on handling quakes (Posted on Columbus Dispatch's website)

By Julie Carr Smyth *ASSOCIATED PRESS* • Tuesday September 29, 2015 6:20 AM

A group of drilling states, seismologists, academics and industry experts issued guidance on Monday in a new report on handling human-induced earthquakes caused by hydraulic fracturing or the disposal of fracking wastewater.

The report, produced by the StatesFirst initiative, represents perhaps the most-candid discussion on the topic since tremors across the mid-continent — including in Ohio, Oklahoma, Texas and Colorado — began being linked to fracking and deep-injection disposal of wastewater around 2009.

It includes descriptions of how states handled seismic incidents, including their public-relations strategies, and it matter-of-factly references links between fracking or deep-injection wastewater disposal and earthquakes. Previously, public admissions had been mostly fuzzy.

The group stopped short of suggesting model regulations.

That's because each state's laws and geography are unique, said Rick Simmers, a co-chairman of the effort. The report says "a one-size-fits-all approach would not be an effective tool for state regulators."

Simmers, chief of the Oil & Gas Resources Management Division of the Ohio Department of Natural Resources, said the report is in the form of a primer, providing states with up-to-date scientific and technical data, case studies and several suggested approaches for detecting and managing the quakes.

Fracking involves blasting water and chemicals into shale formations to fracture the rock and release oil, natural gas and natural-gas liquids trapped inside. The process involves thousands of gallons of water that becomes contaminated and must be trucked away and deposited at special deep-injection facilities.

Both processes have been associated with human-induced tremors, including some easily felt by people.

Simmers said the report conveys a plethora of important information, directing states on such issues as siting, well depth, construction methods, faults present at the site and how to judge an area's seismic history.

"Those two oil-and-gas activities do create some seismicity," Simmers said. "It is very rare. If you compare it to the amount of fluid that's injected for disposal, or the amount of fluid and the number of jobs that occur for hydraulic fracturing, it's very rare. But it does occur.

"It is safe. We monitor the operations very carefully, as do our counterparts in other states."

The working group arose after Ohio's discovery in April 2014 of a probable link between fracking and five small tremors near Youngstown. It was the first time that the new oil-and-gas drilling technique that had been sweeping the country had been linked to seismic activity in the eastern U.S., the second time in the U.S. and only the fourth time worldwide.

Earlier, Ohio Gov. John Kasich had halted disposal of fracking wastewater surrounding a well site in the Youngstown area after a public outcry over a series of earthquakes later determined to have been linked to a deep-injection well.

The StatesFirst coalition partnered with the Interstate Oil and Gas Compact Commission and the Ground Water Protection Council in the effort, which began last year.

The group gathered scientific research on the issue as a service to the 13 participating states: Ohio, Alaska, Arkansas, California, Colorado, Illinois, Indiana, Kansas, Oklahoma, Texas, Utah, West Virginia and Wyoming. Many of the states have not experienced an earthquake induced by fracking or wastewater disposal, but the report urges them to put regulations and procedures in place for dealing with an incident, including strategies for relaying information to the public.

"Induced seismicity is a complex issue where the base of knowledge is changing rapidly," said Kansas Geological Survey interim director Rex Buchanan, a working group co-chairman. "State regulatory agencies that deal with potential injection-induced seismicity should be prepared to use tools, knowledge and expertise — many of which are offered in this primer — to prepare for and respond to (any) occurrences."

The report focuses primarily on deep injection wells for drilling wastewater. The vast majority of such wells have never been tied to earthquakes, but it is more likely that a tremor would come from one of those wells than from a hydraulically fractured well.

Wastewater containing chemicals, brine, naturally occurring radiation and mud is injected directly into basement rocks or into overlying formations that contain crevices into the basement rock. When this occurs near a sensitive fault, tremors can occur.

http://www.dispatch.com/content/stories/local/2015/09/29/states-get-advice-on-handling-quakes.html

Geologists urge state-level approach to earthquakes from wastewater injection (Topeka Capital Journal)
Kansas already has some restrictions
Posted: September 28, 2015 - 6:15pm

By Megan Hart
megan.hart@cjonline.com

A group of state regulators, industry representatives and others urged a state-level approach to addressing earthquakes linked to oil and gas drilling.

Earthquakes in the plains region have increased dramatically since 2009. The U.S. Geological Survey recorded 855 earthquakes with a magnitude of 3 or higher from 1973 to 2008, but the rate increased to 1,855 earthquakes from 2009 to Aug. 15 of this year. Most of those earthquakes were in Oklahoma, but a few were recorded in southeast Kansas. People can't feel earthquakes below magnitude 3.

Research has linked the earthquakes to injecting waste fluids from oil and gas extraction, which are primarily saltwater. The actual drilling itself and hydraulic fracturing, which involves injecting a mix of fluids and sand to free oil and gas trapped within rock, don't appear to have caused earthquakes in Kansas and Oklahoma.

Leslie Savage, chief geologist with the Railroad Commission of Texas, said the geological formations under each state and other conditions vary, so each state will need to determine what hazards it may be susceptible to, the risk of those hazards impacting people living there and what measures to take. For example, some states might elect to prohibit injection near faults that are at a greater risk of causing earthquakes, require additional seismic monitoring, or set up a process to suspend injection if there is evidence it is inducing quakes, she said.

"A one-size-fits-all regulatory approach is not appropriate for this issue," she said.

The Kansas Corporation Commission placed limits on the amount of saltwater that could be injected in Sumner and Harper counties starting in March. Early data suggests the number of earthquakes has fallen since then, but the USGS isn't ready to declare if the limits have had their desired effect, or if the lower rate since March could be due to chance.

Rex Buchanan, interim director of the Kansas Geological Survey, pointed to gaps in knowledge about induced seismicity. Faults in the deep subsurface, or "basement," rock aren't well-mapped, he said, and it isn't clear which faults are under enough stress to produce earthquakes if injection increases the pressure around them.

"It takes a real unusual set of circumstances to induce seismology," he said.

Geologists also don't know the maximum magnitude an injection-induced earthquake could reach. Most induced quakes in Kansas have been smaller than magnitude 5, which is where structural damage generally begins, Buchanan said. Larger earthquakes in Asia have been linked to natural gas drilling or building dams, however.

Ivan Wong, principal seismologist with consulting company AECOM, said states also need to be careful to sort out which earthquakes actually are caused by human activities. Much of the central United States has few seismic monitoring stations, he said, so location data can be off by as much as 6 miles, making it even more difficult to establish a link.

"Just because an earthquake occurs, doesn't mean it's induced," he said.

Rick Simmers, chief of the Ohio Department of Natural Resources, emphasized the report wasn't intended to be a template for potential state regulations. It also didn't address how states might pay for increased seismic monitoring.

The working group included representatives of state regulatory agencies, the Groundwater Protection Council and the Interstate Oil and Gas Compact Commission. Oil and gas industry representatives gave input, as did representatives of the USGS and university geology departments. The report had been in the works since May 2014. Participating states included Alaska, Arkansas, California, Colorado, Illinois, Indiana, Kansas, Ohio, Oklahoma, Texas, Utah, West Virginia and Wyoming.

Megan Hart can be reached at (785) 295-5659 or megan.hart@cjonline.com.
Follow Megan on Twitter @meganhartMC.

http://cjonline.com/news/business/2015-09-28/geologists-urge-state-level-approach-earthquakes-wastewater-injection

U.S. Drilling States Issue Report On Handling Human-Induced Earthquakes (CBS DFW)
September 28, 2015 11:37 AM

COLUMBUS, Ohio (CBSDFW.COM/AP) — A group of U.S. drilling states, seismologists, academics and industry experts issued guidance Monday in a frank new report on handling human-induced earthquakes caused by hydraulic fracturing or the disposal of fracking wastewater.

The 150-page report, produced by the StatesFirst initiative, represents perhaps the most candid discussion on the topic since tremors across the mid-continent — including in Texas, Oklahoma, Colorado and Ohio — began being linked to fracking and deep-injection wastewater disposal around 2009.

It includes descriptions of how states handled various seismic incidents around the country, including their public relations strategies, and matter-of-factly references links between fracking or deep-injection wastewater disposal and earthquakes. Previously, public admissions had been fuzzy in some cases.

The group stopped short of suggesting model regulations, however.

That's because each state's laws and geography are unique, Ohio Oil & Gas Chief Rick Simmers, who co-chaired the effort, told The Associated Press. The report says "a one-size-fits-all approach would not be an effective tool for state regulators."

Simmers said the report is in the form of a primer, providing states with up-to-date scientific and technical data, case studies and several suggested approaches for detecting and managing the quakes.

In Texas, a state inquiry found that an oil and gas company's disposal well operations likely did not cause a series of North Texas earthquakes. The findings directly contradict a study published by Southern Methodist University geologists, pinning the earthquakes to the XTO well and a well operated by Houston-based Enervest.

Fracking involves blasting water and chemicals into shale formations to fracture the rock and release oil,natural gas and natural gas liquids trapped inside. The process involves thousands of gallons of water that becomes contaminated and must be trucked offsite and deposited at special deep-injection facilities.

Both processes have been associated with human-induced tremors, including some easily felt by people.

Simmers said the report conveys a plethora of important information, directing states on such issues as siting, well depth, construction methods, faults present at the site and how to judge an area's seismic history.

“Those two oil-and-gas activities do create some seismicity. It is very rare. If you compare it to the amount of fluid that’s injected for disposal or the amount of fluid and the number of jobs that occur for hydraulic fracturing, it’s very rare. But it does occur,” Simmers said. “It is safe. We monitor the operations very carefully as do our counterparts in other states.”

The working group arose after Ohio’s discovery in April 2014 of a probable link between fracking and five small tremors in eastern Ohio near Youngstown. It was the first time in the Northeast that the new oil-and-gas drilling technique that had been sweeping the country had been linked to seismic activity, the second time in the U.S. and only the fourth time worldwide.

Earlier, Ohio Gov. John Kasich had halted disposal of fracking wastewater surrounding a well site in the same region after a series of earthquakes later tied to a deep-injection well caused a public outcry.

The StatesFirst coalition partnered with the Interstate Oil and Gas Compact Commission and the Ground Water Protection Council in the effort, which began last year.

The group gathered the most current science on the issue as a service to the 13 participating states: Texas, Alaska, Arkansas, California, Colorado, Illinois, Indiana, Kansas, Ohio, Oklahoma, Utah, West Virginia and Wyoming. Many have not experienced any earthquakes induced by fracking or wastewater disposal, but the report urges them to put regulations and procedures in place for dealing with any eventual incidents, including strategies for relaying the information to the public.

“Induced seismicity is a complex issue where the base of knowledge is changing rapidly,” said Kansas Geological Survey interim director Rex Buchanan, a working group co-chair. “State regulatory agencies that deal with potential injection-induced seismicity should be prepared to use tools, knowledge, and expertise — many of which are offered in this primer — to prepare for and respond to (any) occurrences.”

The report focuses primarily on deep injection wells for drilling wastewater, known as Class II wells. The vast majority of such wells have never been tied to earthquakes, but it is more likely that a tremor would come from one of those wells than from a hydraulically fractured well.

Wastewater containing chemicals, brine, naturally occurring radiation and mud is injected directly into basement rocks or into overlying formations that contain crevices into the basement rock. When this occurs near a sensitive fault, tremors can occur.

http://dfw.cbslocal.com/2015/09/28/u-s-drilling-states-issue-report-on-handling-human-induced-earthquakes/

Regulatory groups release earthquake report (The Oklahoman)

Energy and water regulators and researchers from more than a dozen states released a policy report Monday on understanding the links between energy production and triggered earthquakes.

by Paul Monies Published: September 28, 2015
Energy and water regulators and researchers from more than a dozen states released a policy report Monday on understanding the links between energy production and triggered earthquakes.

The report, from the StatesFirst initiative organized by the Interstate Oil and Gas Compact Commission and the Ground Water Protection Council, surveys the latest research and policy options for regulators dealing with higher rates of earthquakes linked to wastewater disposal wells from energy production.

For Oklahoma residents, the issues aren't new. The state has had more than 670 earthquakes greater than magnitude 3.0 this year, surpassing the 585 earthquakes in that category for all of 2014.

Regulators at the Oklahoma Corporation Commission have instituted a “traffic light” system for permitting wastewater disposal wells in areas of increased seismicity. The commission also has directed operators to reduce volumes, cut disposal well depths or shut in some wells in counties across the state.

“In Oklahoma, we're way past potential for induced seismicity,” said Michael Teague, Oklahoma's secretary of energy and environment. “We're in the middle of this problem. But if you're a state like Idaho that doesn't have a whole lot of oil and gas activity, this is a helpful document. It's got all kinds of expertise: regulators, industry folks, researchers at the academic institutions.”

Amid concerns over induced seismicity, a handful of Oklahoma residents have petitioned the Environmental Protection Agency to take over Oklahoma's regulation of the Class II wastewater disposal wells used in energy

http://newsok.com/article/5450013

Innovation and Intellectual Property | Mon Sep 28, 2015 4:28pm EDT
Related: SCIENCE, ENVIRONMENT, NATURAL DISASTERS

More research needed on U.S. earthquakes possibly tied to oil and gas work: report (Reuters)

BY CAREY GILLAM

A coalition of U.S. states warned on Monday that a spike in earthquakes potentially tied to oil and gas activity in places not typically prone to them needs urgent attention from regulators and others to protect public safety.

The report to be released later on Monday by States First includes input from governors, regulators and oil and gas policy leaders in 13 states, including Oklahoma and Kansas, where earthquake activity and intensity have risen in recent years.

The report focused on ties between quakes and wastewater injection from oil and gas production work.

"We see something very new and different happening here in the mid-continent," said Rex Buchanan, interim director of the Kansas Geological Survey and co-chair of the group that issued the report. "We're not used to this level of seismicity."

Oklahoma is recording 2.5 earthquakes daily of a magnitude 3 or greater, a seismicity rate 600 times greater than observed before 2008, according to a report in April by the Oklahoma Geological Survey.

The report's aim is to equip states with tools to evaluate connections between seismic events and injection wells, minimize risk, and be ready when seismic events occur.

Many people have associated the process of hydraulic fracking with earthquakes, but the U.S. Geological Survey said in April that the actual hydraulic fracturing process is only occasionally the direct cause of felt earthquakes. (on.doi.gov/1KGiLzy)

Large volumes of wastewater can result from a variety of industrial processes, including energy production, and several scientific studies have shown that some of the increase in seismic activity in parts of the United States has been "induced" by wastewater injections.

Officials from Illinois, Arkansas, Texas, Indiana, Colorado, Alaska, California, Utah, West Virginia and Wyoming also contributed to the report.

The report suggested several steps that could be taken by states to reduce risk to residents including improving monitoring of seismic activity and well work, direct injection of wastewater into certain faults, and establishing procedures to suspend wastewater injection when seismic activity rises to worrisome levels.

The report said one problem is a lack of good information mapping faults, particularly those at or near critical stress points. Researchers also said they do not know how large an earthquake induced by wastewater injection could potentially be.

"The research needs out here are great. We can't see what's going on down there," said Buchanan. "Being able to understand this is a challenge."

(Reporting by Carey Gillam in Kansas City, Missouri; Editing by Lisa Shumaker)

http://www.reuters.com/article/2015/09/28/us-usa-quake-oilandgas-idUSKCN0RS2HV20150928

Ohio, 12 other states working to mitigate quake risks(Akron Beacon Journal blog)
By BOB DOWNING Published: September 29, 2015
From a Monday press release:

State Primer Provides Guidance in Mitigating Risks of Induced Seismic Events
Work group creates recommendations in State Primer

OKLAHOMA CITY – Thirteen states partnered through a multi-state initiative called StatesFirst this past year to share and summarize current knowledge related to earthquakes potentially caused by human activity, otherwise referred to as induced seismicity.

Today, the work group comprised of members of state oil and natural gas and geological agencies and other advisory experts from academia, industry, non-profit organizations and federal agencies released a Primer to provide a guide for regulatory agencies to evaluate and develop strategies to mitigate and manage risks of injection induced seismicity. The Primer also outlines how states can best provide information to the public in a transparent and effective manner.

“Induced seismicity is a complex issue where the base of knowledge is changing rapidly,” according to Rex Buchanan, work group co-chair and interim director of the Kansas Geological Survey. “State regulatory agencies that deal with potential injection induced seismicity should be prepared to use tools, knowledge, and expertise, many of which are offered in this Primer, to prepare for and respond to potential occurrences of induced seismicity.”

The primer primarily focuses on potential induced seismicity associated with Class II disposal wells. Injection wells are currently regulated under the Safe Drinking Water Act through the Underground Injection Control Program (UIC). The UIC program through primacy delegation by the U.S. EPA, is administered by certain states due to their in-depth knowledge of local industry operations and geology.

In its assessment, the work group observed that the majority of disposal wells in the United States do not pose a hazard for induced seismicity; however most cases of felt injection-induced earthquake activity has generally

been associated with direct injection into basement rocks or injection into overlying formations with permeable avenues of communication with the basement rocks, and in proximity to faults of concern.

In areas where induced seismicity is thought to have occurred, the Primer also identifies the range of multi-disciplinary approaches states have used to manage and mitigate risks, discusses scientific methods for evaluating cause, identifies faults of concern, and distinguishes risks and hazards.

“Overall the risk of induced seismicity for oil and gas operation is still low,” said Rick Simmers, work group co-chair and chief of the Ohio Department of Natural Resources, Division of Oil and Gas Resources Management. “It is clear that local factors in different parts of the country present different levels of risk. Because of this, risk management, mitigation, and response strategies are most effective when developed considering specific local geology, surface conditions as well as other local situations.”

To download the Primer or to view an in-depth Webinar featuring commentary from key work group participants, visitwww.statesfirstinitiative.org.

http://www.ohio.com/blogs/drilling/ohio-utica-shale-1.291290/ohio-12-other-states-working-to-mitigate-quake-risks-1.628042

Stephanie Leis
Public Information Officer
Ohio Department of Natural Resources
2045 Morse Road, Building D-3
Columbus, Ohio 43229
614-265-6874
Stephanie.Leis@dnr.state.oh.us

Sent from my iPhone

On Sep 30, 2015, at 5:23 AM, Ben Grunewald <ben@gwpc.org> wrote:

> Rick, Rex, Leslie, Ivan and Mike presented the primer flawlessly!
>
> http://m.newsok.com/regulatory-groups-release-earthquake-report/article/5450013
>
> Sent from my iPhone
>
> On Sep 29, 2015, at 4:01 PM, Ben Grunewald <ben@gwpc.org> wrote:
>
> ---
>
> Dear Induced Seismicity Workgroup members and Technical Advisors:
>
> On behalf of the Editorial Committee, I want to thank you again for your participation in this important initiative.
>
> UPDATE:
>
> The primer is FINISHED and may be accessed and distributed widely at www.statesfirstinitiative.org.

Ben Grunewald
ISWG Coordinator
405 516 4972

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, September 29, 2015 4:00 PM
To: R6 6WQ-SG
Subject: IOGCC & GWPC role out of their Induced Seismicity Primer

If you care to watch or listen to one more take on Induced Seismicity, this has a 'webinar' link. Actually, it is just a powerpoint with sound. And the downloadable pdf. Phil and I were on the workgroup, plus Bill Bates and Holly Green from HQ.
http://www.statesfirstinitiative.org/#!induced-seismicity-work-group/cwed

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, September 25, 2015 7:54 AM
To: R6 6WQ-SG; Brown, Jamesr; Lawrence, Rob; Honker, William; Garcia, David
Cc: Green, Holly; Bates, William; Hildebrandt, Kurt
Subject: FW: 2015-09-25 01:16:38 (M4.0) OKLAHOMA 36.0 -96.8 (63093) CUSHING Two Earthquakes Cause Power Outages In Payne County

Importance: High

http://www.news9.com/story/30112258/40-earthquake-recorded-in-payne-county

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Thursday, September 24, 2015 8:26 PM
To: Dorsey, Nancy
Subject: 2015-09-25 01:16:38 (M4.0) OKLAHOMA 36.0 -96.8 (63093)

M4.0 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.0
Date-Time	25 Sep 2015 01:16:38 UTC 24 Sep 2015 20:16:38 near epicenter 24 Sep 2015 18:16:38 standard time in your timezone
Location	35.990N 96.840W
Depth	5 km
Distances	6 km (3 mi) W of Cushing, Oklahoma 24 km (14 mi) SE of Stillwater, Oklahoma 54 km (33 mi) ENE of Guthrie, Oklahoma 65 km (40 mi) W of Sapulpa, Oklahoma 84 km (52 mi) NE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 3.0 km; Vertical 6.9 km
Parameters	Nph = 71; Dmin = 4.5 km; Rmss = 0.61 seconds; Gp = 27° Version =
Event ID	us 20003nwb

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

Disclaimer

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To change your parameters, go to:

https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, September 24, 2015 1:19 PM
To: Bierschenk, Arnold
Subject: your mission should you decide to accept
Attachments: ENE series.docx

In a moment of boredom…

You can only sign in to the Enid News articles a maximum number of times (4?), and I didn't copy the article the first time. ☹

I have already snagged part 1, 2 and 12.

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, September 23, 2015 9:19 AM
To: Honker, William; Brown, Jamesr; Dellinger, Philip
Cc: Garcia, David; R6 6WQ-SG; Bates, William; Hildebrandt, Kurt; Lawrence, Rob
Subject: EARTHQUAKE EXPLOSION: State's seismic surge opened floodgates of data, cooperation & Corporation Commission Turns Away 5 Disposal Well Applications

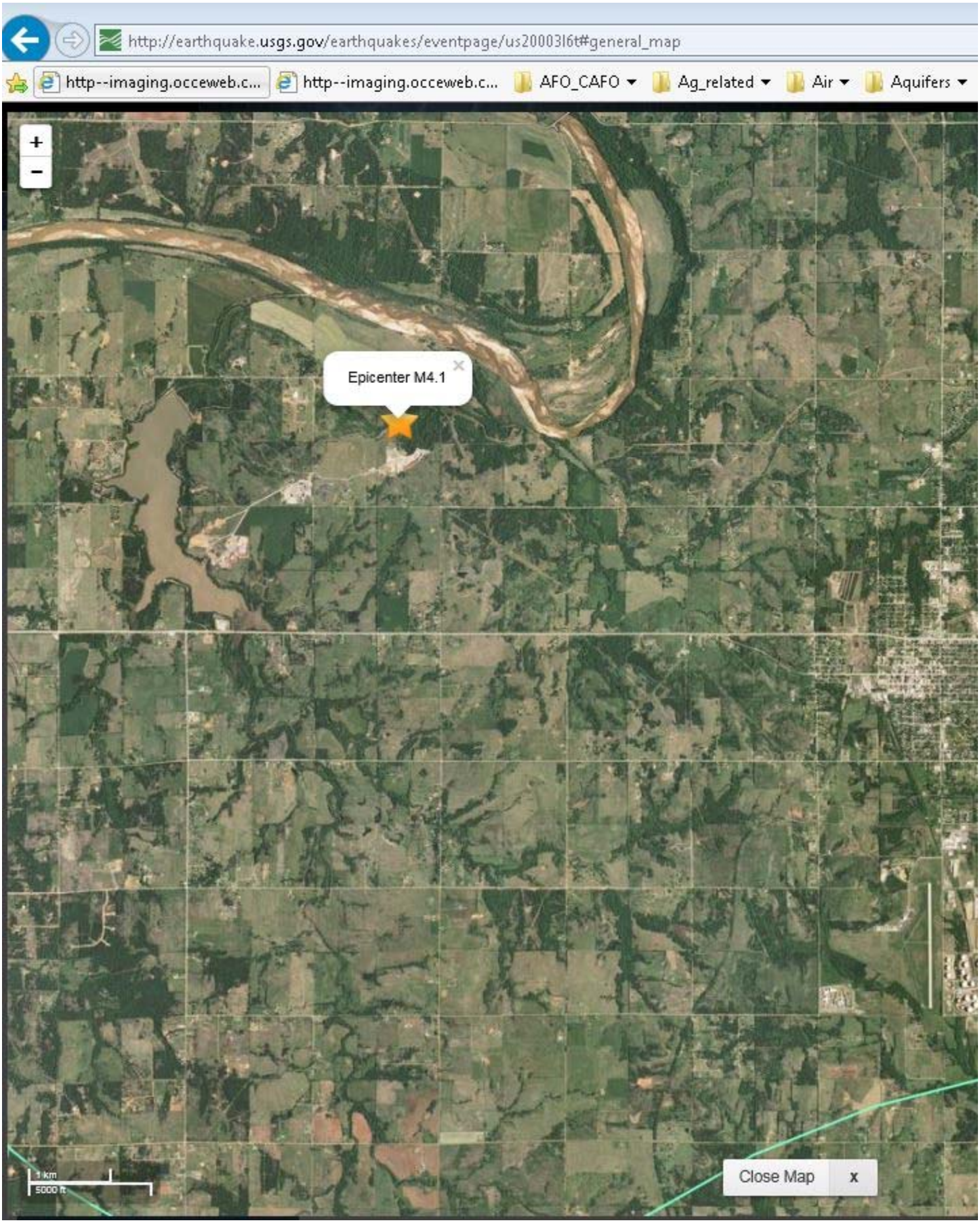
http://www.enidnews.com/news/local_news/earthquake-explosion/article_75b43a9a-dfdb-5f82-bb12-af6578006780.htmlhttp://www.enidnews.com/news/local_news/earthquake-explosion/article_75b43a9a-dfdb-5f82-bb12-af6578006780.html

http://www.news9.com/story/30092566/corporate-commission-turned-away-5-disposal-well-applications "OKLAHOMA CITY - Another sign that it's no longer business as usual for many oil and gas companies here in earthquake-rich Oklahoma: five disposal well applications were turned away at Tuesday morning's meeting of the Oklahoma Corporation Commission."

http://www.news9.com/story/30064980/2-cushing-disposal-wells-shut-down-following-earthquakes CUSHING, Oklahoma - Two wastewater disposal wells will stop operations in Cushing, Oklahoma, following a series of earthquakes that hit the area, according to the Oklahoma Corporation Commission.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, September 18, 2015 8:38 AM
To: R6 6WQ-SG; Brown, Jamesr; Bates, William; Lawrence, Rob
Subject: RE: 2015-09-18 12:35:17 (M4.1) OKLAHOMA 36.0 -96.8 (63093) Cushing 4.1


http://earthquake.usgs.gov/earthquakes/eventpage/us20003l6t#general_map
http--imaging.occeweb.c...
http--imaging.occeweb.c...
AFO_CAFO
Ag_related
Air
Aquifers
+
−
Epicenter M4.1
1 km
5000 ft
Close Map
x

M4.1 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.1
Date-Time	18 Sep 2015 12:35:17 UTC 18 Sep 2015 07:35:18 near epicenter 18 Sep 2015 05:35:17 standard time in your timezone
Location	36.010N 96.844W
Depth	3 km
Distances	7 km (4 mi) WNW of Cushing, Oklahoma 22 km (13 mi) ESE of Stillwater, Oklahoma 54 km (33 mi) ENE of Guthrie, Oklahoma 65 km (40 mi) W of Sapulpa, Oklahoma 85 km (52 mi) NE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 1.8 km; Vertical 7.4 km
Parameters	Nph = 70; Dmin = 6.6 km; Rmss = 0.52 seconds; Gp = 27° Version =
Event ID	us 20003l6t

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

Disclaimer

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https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, September 18, 2015 8:26 AM
To: R6 6WQ-SG; Brown, Jamesr; Bates, William; Lawrence, Rob
Subject: FW: 2015-09-18 12:35:17 (M4.1) OKLAHOMA 36.0 -96.8 (63093) Cushing 4.1

Tank farm area

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Friday, September 18, 2015 7:49 AM
To: Dorsey, Nancy
Subject: 2015-09-18 12:35:17 (M4.1) OKLAHOMA 36.0 -96.8 (63093)

M4.1 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.1
Date-Time	18 Sep 2015 12:35:17 UTC 18 Sep 2015 07:35:18 near epicenter 18 Sep 2015 05:35:17 standard time in your timezone
Location	36.010N 96.844W
Depth	3 km
Distances	7 km (4 mi) WNW of Cushing, Oklahoma 22 km (13 mi) ESE of Stillwater, Oklahoma 54 km (33 mi) ENE of Guthrie, Oklahoma 65 km (40 mi) W of Sapulpa, Oklahoma 85 km (52 mi) NE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 1.8 km; Vertical 7.4 km
Parameters	Nph = 70; Dmin = 6.6 km; Rmss = 0.52 seconds; Gp = 27° Version =
Event ID	us 20003l6t

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

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You requested mail for events within the 'R6 plus CO' region
for M1.0 between 08:00 and 20:00 and M1.5 other times.

To change your parameters, go to:

https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, September 10, 2015 3:36 PM
To: R6 6WQ-SG; Hildebrandt, Kurt; Bates, William
Cc: Charles Lord; Megan Crocker (M.Crocker@occemail.com); Jim Marlatt; Patricia Downey
Subject: Abstracts of note for GWPC meeting Water & Energy: Induced Seismicity by Underground Injection

Abstract 20

Modeling of Pressure Propagation from Saltwater Disposal Wells Completed in the Arbuckle Group, northern Oklahoma

Kyle E. Murray, Oklahoma Geological Survey

Dr. Kyle E. Murray is a Hydrogeologist for the Oklahoma Geological Survey (OGS) and Adjunct Faculty for the ConocoPhillips School of Geology and Geophysics at the University of Oklahoma (OU). He investigates physical and chemical properties of geologic materials that store and produce fluids, and tends toward regional-scale studies of water, earth, and environmental resources. Water management in the energy industry is currently his primary research area, which includes study of water use in exploration and production, co-production of petroleum and water, saltwater management, disposal, recycle, and reuse.

The Arbuckle Group, a predominantly carbonate deposit, is the main zone for disposal of wastewater that was co-produced from petroleum wells in Oklahoma. Bottom-hole pressure data from over 1100 drill-stem tests collected over several decades indicates that the Arbuckle was underpressured when wells were completed. Sixty percent (60%) of the Arbuckle saltwater disposal (SWD) wells operating in Oklahoma from 2010–2013 were reportedly functioning with negative wellhead pressure, which suggests that the majority of the Arbuckle is still underpressured. The purpose of this study was to improve our understanding of pressure change in the Arbuckle as a result of fluid production or injection. A groundwater model was constructed and used to simulate spatial and temporal distribution of pressure under nine different scenarios or hydrogeologic conditions. The model scenarios indicate that pressure at the fault zones may increase substantially within a 6-mile radius of the SWDs, a radial distance around a SWD well that is examined for seismicity when invoking the 'Traffic Light System'. Injection scenarios show that fluid pressure in the Arbuckle is propagating both laterally and vertically (downward) away from the SWD wells and into the granitic basement as opposed to upward into the Simpson Group. Modeling also demonstrated that pressure may increase by a factor of two or more when a fault zone is represented as a barrier to flow using a relatively low permeability. Conversely, pressure at the fault zones may substantially decrease due to production from the Arbuckle. Other scenarios indicate that well depth, length of open interval, and completion type will have a substantial effect on pressure changes in the Arbuckle and overlying or underlying zones.

Abstract 40

Understanding, Quantifying and Managing Risk from Injection-Related Earthquakes: A Case Study from Oklahoma

Rall Walsh, Randi J. Walters, Mark D. Zoback, Jack W. Baker, and Greg C. Beroza Stanford University

Over the past six years, the earthquake rate in the central and eastern U.S. has increased markedly, in many cases apparently related to fluid injection associated with oil and gas activities. Development of methodologies for understanding, quantifying and managing the risks these earthquakes potentially pose is a considerable challenge for both regulators and oil and gas operators. Nowhere has seismicity increased more markedly than in Oklahoma. In three study areas that encompass the majority of Oklahoma's recent

earthquakes, we show that the increase in seismicity follows a significant increase in saltwater disposal that comes principally from produced water, saline pore water that is co-produced with oil and gas, then injected into deeper sedimentary formations. These deeper formations appear to be in hydraulic communication with potentially active faults in crystalline basement, where nearly all the earthquakes are occurring. Although the majority of the recent earthquakes have posed little danger to the public, the possibility of triggering damaging earthquakes on potentially active basement faults cannot be discounted. Going forward, we suggest a science-based method to characterize and mitigate the risk associated with injection-related seismicity. This includes a comprehensive geologic, hydrologic, and geomechanical site characterization and risk assessment, using Probabilistic Seismic Hazard Analysis (PSHA) as the foundation. In addition, we recommend use of a site-adaptable and proactive traffic light system. We encourage measures that are risk based, adaptable, goal oriented, and rely, to the degree possible, on well-established procedures and recommendations.

Rall Walsh is a 5th year Ph.D. candidate in the Stanford Department of Geophysics. He was the Teaching Assistant for Stanford's 2015 online offering of Reservoir Geomechanics, successfully completed by over 2,000 students from over 100 countries. Rall has interned in Geomechanical technology research units at two major energy companies, and collaborates with many others through the Stanford Center for Induced and Triggered Seismicity, and the Stanford Rock and Borehole Geophysics consortium.

Abstract 56

Investigating Injection-Induced Seismicity through Reservoir Modeling and Simulation of the Arbuckle Saline Aquifer, South-Central Kansas

Tandis S. Bidgoli, Mina FazelAlavi, and Yevhen Holubnyak, Kansas Geological Survey

Tandis Bidgoli is an Assistant Scientist with the Energy Research Section of the Kansas Geological Survey (KGS) and a Courtesy Assistant Professor in the Department of Geology at the University of Kansas. She earned a M.S. from the University of Nevada and a Ph.D from the University of Kansas. Prior to joining the KGS, she contributed to a number of industry projects as an Exploration Geologist for ExxonMobil. She is a structural geologist and low-temperature thermochronologist that focuses on the evaluation of subsurface geologic systems for energy exploration and development.

The Cambro-Ordovician Arbuckle Group is one of the principle reservoirs used for UIC Class I and II injection in the central U.S. A number of factors have contributed to its predominance as a disposal interval, including its depth and confinement from underground sources of drinking water; thickness (up to ~400 m); high permeability (10-1500 mD); and low pressure (below hydrostatic). However, recent seismicity in Kansas may be challenging assumptions about the Arbuckle being an ideal disposal zone, particularly for large volume injection. From 2013-2015, more than 200 earthquakes occurred in a two-county area in the south-central part of the state. The seismicity is temporally and spatially coincident with major brine disposal operations, raising concerns about the safety and efficacy of underground fluid injection. To evaluate these issues and potential mitigating strategies, we constructed a geologic model of the Arbuckle in Petrel™. The model incorporates reservoir property data from ~18 wells and dynamic data from 103 saltwater disposal wells, covering a 5500 km² area. Well data were analyzed using a wide range of techniques in order to determine porosities, horizontal and vertical permeabilities, water saturations, and flow units within the Arbuckle. The resulting 20 layer geologic model was simulated in CMG™ and shows an increase in reservoir pressure across the model area after 26 years of injection. The largest change in reservoir pressure occurs near the highest rate injection wells; however, the simulations also show that there is a broader cumulative pressure response across the model area. Although the change in pressure near the Arbuckle-basement interface is not large (10-70 psi), hydraulic connections via critically-stressed basement faults could transmit fluid pressure deeper and trigger seismicity.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, August 06, 2015 3:20 PM
To: Bates, William
Subject: articles
Attachments: Wall Street version; better links

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, August 06, 2015 1:08 PM
To: Dellinger, Philip
Subject: hmmm

"In the U.S., Federal and jurisdictional guidelines have been established for damage and nuisance due to vibrations from manmade activities such as blasting, transportation, mining activities, and construction activities (Majer et al., 2012). Vibration is most commonly generated by ground shaking but can also be in the form of ground-borne noise. We focus on the former in this section. For example, the U.S. Bureau of Mines has defined blasting-induced threshold cracking limits for peak particle velocity (PPV) (equal to peak ground velocity) to avoid cosmetic damage to buildings (U.S. Bureau of Mines Report of Investigations 8507; Siskind et al., 1980). The U.S. Bureau of Mines criteria for threshold damage are widely used for construction and blasting vibration monitoring but more recent studies indicate that these criteria need to be revisited (Majer et al., 2012)."

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, August 06, 2015 12:45 PM
To: R6 6WQ-SG; Matt Skinner; Charles Lord; Tim Baker; Patricia Downey
Subject: Wall Street version

Fracking-Related Earthquakes Could Ding Credit Quality

- **Article**
- **Comments (4)**

- CREDIT QUALITY
- EARTHQUAKES
- FRACKING

Email Print
4
24
7

- By
- Maxwell Murphy
  - @kmaxwellmurphy
  - Biography
- CONNECT
  - @kmaxwellmurphy
  - Biography

Wildcat wireline contractors remove a fracking device from an oil well on a Goodrich Petroleum field on the Burns Ranch near Dilley, Texas on Tuesday, January 3, 2012. Ben Sklar for the Wall Street Journal Published Credit: Benjamin Sklar for The Wall Street Journal Published Credit: Benjamin Sklar for The Wall Street Journal

Benjamin Sklar for The Wall Street Journal

More and stronger earthquakes, and the possible link to oil and gas drilling activities, could have far reaching economic implications, according to Standard & Poor's Ratings Services.

"The earthquake trend has and will continue to have sharp economic consequences for home and business owners, mortgage lenders, insurance companies, and investors exposed to real estate in earthquake affected areas," S&P analysts said.

S&P noted that Oklahoma, a popular site for horizontal drilling and hydraulic fracturing, or fracking, had 585 earthquakes last year. That's up from an average of one or two a year before fracking was introduced in 2008 and more than triple the annual number in earthquake-prone California.

Companies exposed to these risks need to assess if they need earthquake coverage, and whether their policies change if the earthquake is declared man-made.

"Whatever the cause," wrote S&P credit analyst Andrew Foster, "we believe the potential for property damage from increased incidences of earthquakes may be a liability."

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, August 06, 2015 12:43 PM
To: R6 6WQ-SG; Matt Skinner; Charles Lord; Tim Baker; Patricia Downey
Subject: better links

http://blogs.barrons.com/incomeinvesting/2015/08/05/sp-fracking-and-man-made-earthquakes-are-a-credit-risk

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, August 04, 2015 8:40 AM
To: Bates, William; R6 6WQ-SG
Cc: Brown, Jamesr
Subject: location of official release

http://www.occeweb.com/News/news.htmv

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, August 04, 2015 8:29 AM
To: Bates, William; R6 6WQ-SG
Subject: FW: OCC media advisory and seismicity
Attachments: 08-03-15LetterSeismicity_Final.docx; ATT00001.htm; New Areas of Interest 8-3-2015 AOI.jpg; ATT00002.htm; LoganPayne_23_wells_8-3-2015_b.xlsx; ATT00003.htm; All_Directive_Area_Of_Interest_Wells_07_31_2015.xlsx; ATT00004.htm; 08-03-15VOLUME PLAN STATEMENT-MURPHY.pdf; ATT00005.htm

---

From: Lawrence, Rob
Sent: Tuesday, August 04, 2015 7:58 AM
To: Dellinger, Philip; Overbay, Michael; Dorsey, Nancy
Cc: Hanley, Mary; Marks, Teresa
Subject: FW: OCC media advisory and seismicity

In case this action has not reached you.

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Gray, David
Sent: Tuesday, August 04, 2015 6:36 AM
To: Lawrence, Rob
Subject: Fwd: media advisory

Sent from my iPhone

Begin forwarded message:

> **From:** "Matt Skinner" <M.Skinner@occemail.com>
> **To:** "Gray, David" <gray.david@epa.gov>
> **Subject: FW: media advisory**
>
> Bob Anthony
> Commissioner
>
> Todd Hiett
> Commissioner
>
> Dana Murphy
> Commissioner
>
> OKLAHOMA

Corporation Commission

OIL & GAS CONSERVATION DIVISION Tim Baker, Director

August 3, 2015 Contact: Matt Skinner
405-521-4180
m.skinner@occemail.com

MEDIA ADVISORY – OIL AND GAS DISPOSAL WELL VOLUME REDUCTION PLAN

The Oklahoma Corporation Commission's Oil and Gas Conservation Division (OGCD) has put in place a plan to reduce oil and gas wastewater disposal well volume in an proscribed area of northern Oklahoma County and southern Logan County. Under the plan, operators will have a 60 day period during which volume will be reduced 38 percent, or about 3.4 million barrels under the 2014 total. Such a reduction will bring total volume for the area to a level under the 2012 total by about 2.4 million barrels. The area saw its sharpest rise in seismicity start in late 2012.

An example of the letter that is being sent out to operators is attached, Also attached is a graphic of what is called the "Logan County trend" area (the impacted area), a listing of the wells and operators involved, and a statement from Commission Vice Chairman Dana Murphy on the matter.

Also attached is the latest report on the April and July "plug-back" actions taken by the OGCD.

This is the latest development under the "traffic light" system". The system was first put in place in 2013 in response to the concerns over the possibility of earthquake activity being caused by oil and gas wastewater disposal wells in Oklahoma. It has been in a state of constant evolution since then, as new data becomes available.

Other elements of the traffic light system include:

- A "plug-back" program covering more than 500 disposal wells. Wells are reducing their depth if found to be at a depth that sharply increases the risk of induced seismicity.

- Required seismicity review for any proposed disposal well.
  - Those proposed wells that do not meet "red light" (stop) standards but are still of concern:
    1. Must have public review

2. Permit is temporary (six months)
3. Permit language requires**
    1. Seismometers
    2. Shut down if rise in background seismicity or there is a defined seismic event
    3. Shut in and perform reservoir pressure testing every 60 days.

    ** Applicant agreement to conditions does not guarantee approval

- Weekly volume reporting requirements for and close scrutiny of all disposal wells in an Area of Interest (AOI):
    - AOI now defined as a 10 kilometer (about 122 square miles) area surrounding the center mass of an earthquake "cluster"
- Rules increasing from monthly to daily the required recording of well pressure and volume from disposal wells that dispose into the Arbuckle formation (the state's deepest injection formation)
- Rules requiring Mechanical Integrity Tests for wells disposing of volumes of 20,000 barrels a day or more have increased from once every five years to every year, or more often if so directed by the Commission

-OCC-

All OCC advisories and releases are available at www.occeweb.com

Editors, Producers: See www.occeweb.com and www.earthquakes.ok.gov for maps, directives and other information on earthquake response

Dorsey, Nancy

From: Lawrence, Rob
Sent: Tuesday, August 04, 2015 7:58 AM
To: Dellinger, Philip; Overbay, Michael; Dorsey, Nancy
Cc: Hanley, Mary; Marks, Teresa
Subject: FW: OCC media advisory and seismicity
Attachments: 08-03-15LetterSeismicity_Final.docx; ATT00001.htm; New Areas of Interest 8-3-2015 AOI.jpg; ATT00002.htm; LoganPayne_23_wells_8-3-2015_b.xlsx; ATT00003.htm; All_Directive_Area_Of_Interest_Wells_07_31_2015.xlsx; ATT00004.htm; 08-03-15VOLUME PLAN STATEMENT-MURPHY.pdf; ATT00005.htm

In case this action has not reached you.

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Gray, David
Sent: Tuesday, August 04, 2015 6:36 AM
To: Lawrence, Rob
Subject: Fwd: media advisory

Sent from my iPhone

Begin forwarded message:

From: "Matt Skinner" <M.Skinner@occemail.com>
To: "Gray, David" <gray.david@epa.gov>
Subject: FW: media advisory

Bob Anthony
Commissioner

Todd Hiett
Commissioner

Dana Murphy
Commissioner

OKLAHOMA
Corporation Commission

OIL & GAS CONSERVATION DIVISION Tim Baker, Director

August 3, 2015 Contact: Matt Skinner
405-521-4180

m.skinner@occemail.com

MEDIA ADVISORY – OIL AND GAS DISPOSAL WELL VOLUME REDUCTION PLAN

The Oklahoma Corporation Commission's Oil and Gas Conservation Division (OGCD) has put in place a plan to reduce oil and gas wastewater disposal well volume in an proscribed area of northern Oklahoma County and southern Logan County. Under the plan, operators will have a 60 day period during which volume will be reduced 38 percent, or about 3.4 million barrels under the 2014 total. Such a reduction will bring total volume for the area to a level under the 2012 total by about 2.4 million barrels. The area saw its sharpest rise in seismicity start in late 2012.

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    - Those proposed wells that do not meet "red light" (stop) standards but are still of concern:
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        2. Permit is temporary (six months)
        3. Permit language requires**
            1. Seismometers
            2. Shut down if rise in background seismicity or there is a defined seismic event
            3. Shut in and perform reservoir pressure testing every 60 days.

** Applicant agreement to conditions does not guarantee approval

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  - AOI now defined as a 10 kilometer (about 122 square miles) area surrounding the center mass of an earthquake "cluster"
- Rules increasing from monthly to daily the required recording of well pressure and volume from disposal wells that dispose into the Arbuckle formation (the state's deepest injection formation)
- Rules requiring Mechanical Integrity Tests for wells disposing of volumes of 20,000 barrels a day or more have increased from once every five years to every year, or more often if so directed by the Commission

-OCC-

All OCC advisories and releases are available at www.occeweb.com

Editors, Producers: See www.occeweb.com and www.earthquakes.ok.gov for maps, directives and other information on earthquake response

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, July 29, 2015 11:32 AM
To: R6 6WQ-SG; Brown, Jamesr; Lawrence, Rob; Bates, William; Hildebrandt, Kurt; Green, Holly
Subject: Light non-structural damage from Crescent OK earthquakes 6.2M in Southern Alaska and 2.8 in Snyder TX

http://newsok.com/crescent-quake-makes-breaks-history/article/5436775

M6.2 - SOUTHERN ALASKA

Preliminary Earthquake Report	
Magnitude	6.2
Date-Time	29 Jul 2015 02:35:58 UTC 28 Jul 2015 18:35:59 near epicenter 28 Jul 2015 19:35:58 standard time in your timezone
Location	59.901N 153.276W
Depth	121 km
Distances	71 km (44 mi) SSW of Redoubt Volcano, Alaska 236 km (146 mi) SW of Anchorage, Alaska 269 km (166 mi) SW of Knik-Fairview, Alaska 620 km (384 mi) SSW of Fairbanks, Alaska 1008 km (624 mi) W of Whitehorse, Canada
Location Uncertainty	Horizontal: 5.7 km; Vertical 5.0 km
Parameters	Nph = 184; Dmin = 69.2 km; Rmss = 1.41 seconds; Gp = 45° Version =
Event ID	us 2000314u

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

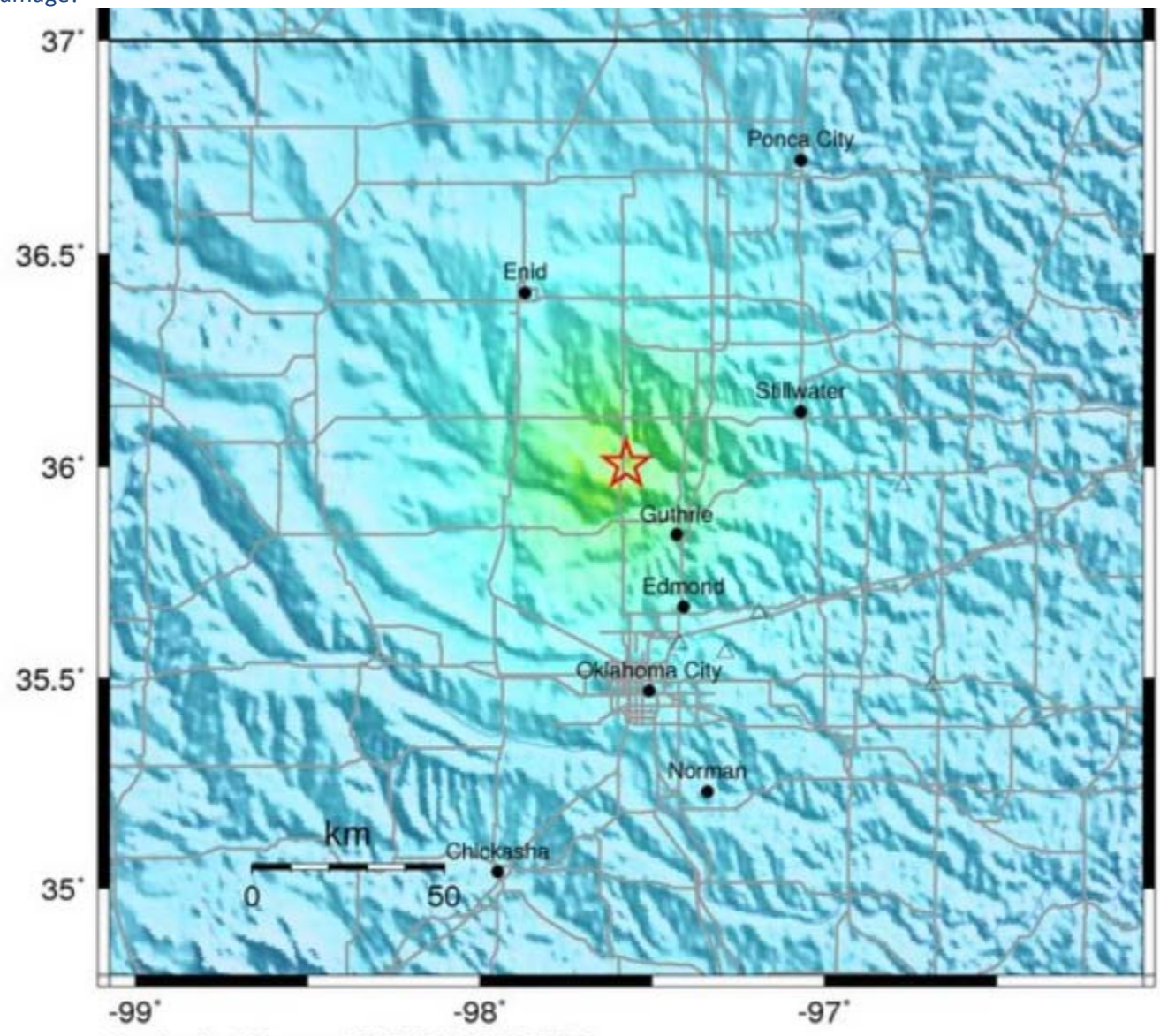
M2.8 - WESTERN TEXAS

Preliminary Earthquake Report	
Magnitude	2.8
Date-Time	29 Jul 2015 01:47:27 UTC 28 Jul 2015 20:47:28 near epicenter 28 Jul 2015 18:47:27 standard time in your timezone
Location	32.913N 100.891W
Depth	5 km
Distances	21 km (13 mi) N of Snyder, Texas 66 km (40 mi) NW of Sweetwater, Texas 91 km (56 mi) NE of Big Spring, Texas 116 km (71 mi) SE of Lubbock, Texas 418 km (259 mi) NW of Austin, Texas
Location Uncertainty	Horizontal: 4.5 km; Vertical 2.0 km
Parameters	Nph = 26; Dmin = 121.6 km; Rmss = 0.58 seconds; Gp = 56° Version =
Event ID	us 2000314m

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, July 27, 2015 1:55 PM
To: R6 6WQ-SG
Subject: RE: 2015-07-27 18:12:15 (M4.5) OKLAHOMA 36.0 -97.6 (63093)

Note that the Shake map shows this as an intensity VI = strong perceived shaking with light potential (structural) damage!



Map Version 1 Processed 2015-07-27 18:30:00 UTC

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.007	0.08	1.0	5.0	8.8	15	27	47	>83
PEAK VEL.(cm/s)	*<0.003*	*0.04*	*0.5*	*3.0*	*6.5*	*14*	*30*	*63*	*>136*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Atkinson & Kaka, 2007

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Monday, July 27, 2015 1:33 PM
To: Dorsey, Nancy
Subject: 2015-07-27 18:12:15 (M4.5) OKLAHOMA 36.0 -97.6 (63093)

M4.5 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.5
Date-Time	27 Jul 2015 18:12:15 UTC 27 Jul 2015 13:12:15 near epicenter 27 Jul 2015 11:12:15 standard time in your timezone
Location	36.006N 97.576W
Depth	3 km
Distances	6 km (3 mi) NNE of Crescent, Oklahoma 19 km (11 mi) NW of Guthrie, Oklahoma 40 km (24 mi) NNW of Edmond, Oklahoma 48 km (29 mi) WSW of Stillwater, Oklahoma 59 km (36 mi) N of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 3.4 km; Vertical 5.1 km
Parameters	Nph = 86; Dmin = 26.0 km; Rmss = 0.50 seconds; Gp = 65° Version =
Event ID	us 200030gd

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

Disclaimer

This email was sent to dorsey.nancy@epa.gov

You requested mail for events within the 'R6 plus CO' region
for M1.0 between 08:00 and 20:00 and M1.5 other times.

To change your parameters, go to:

https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, July 21, 2015 3:15 PM
To: Lawrence, Rob
Subject: RE: poor showing re well count and tracking

Yes it is.

From: Lawrence, Rob
Sent: Tuesday, July 21, 2015 3:08 PM
To: Dorsey, Nancy
Subject: Re: poor showing re well count and tracking

USU might be Utah State

Sent from my iPhone

On Jul 21, 2015, at 3:05 PM, Dorsey, Nancy <Dorsey.Nancy@epa.gov> wrote:

> No surprise here!
>
> The following article was not available on google scholar, nor does it list whether it was ever published.
>
> # How Many Class II Wells Present a Risk for Induced Seismicity?
>
> **Authors**
>
> **Isaac Allre**Follow
> **Michael David**
> **Berry Parslow**
>
> **Document Type**
>
> Presentation
>
> **Journal/Book Title/Conference**
>
> USU Student Showcase
>
> **Publication Date**
>
> 4-2014
>
> **Faculty Mentor**
>
> James Evans

Abstract

We examine the number and location of Class II wells in the central U.S. to constrain future work on the potential for induced seismicity. The EPA, state oil & gas commissions, scientific papers, and media stories frequently state that there are ~140-160 k Class II wells. Excluding California, we expected to find approximately 120 k wells; but instead found ~82 k active injectors in the available databases. State datasets vary in accessibility, availability, and content of well data. Lack of digitized well data also limited our online search, and several states require FOIA requests to be filed. State databases with poor searching and sorting functions further complicated data mining, requiring a well-by-well search, and for several states, well locations and injections were difficult to determine. Common discrepancies between EPA well totals and state database totals appear to be due to counting of plugged and abandoned wells, and wells that are permitted but not in use. No data has been retrieved for about 1,600 wells on tribal lands and Indian Country, and several states would not provide confidential well data. Of the active injectors, at least 55 k wells inject into producing, pressure-depleting oil and gas formations and are less likely to generate damaging earthquakes. Of the ~16 k non-EOR wells, we found 3,400 wells that inject at depths > 1.8 km, where most M > 3.0 midcontinent earthquakes occur. We will present examples of data from several states, that show the locations and depths of injectors, earthquakes, depth to basement, and we will provide an overview of the public file sharing system of the data. We will search for correlations between the depth of injection, the number of injection wells, recent seismic activity, the nature of the subsurface geology, and regional stresses.

8

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, July 21, 2015 2:59 PM
To: Gillespie, David
Subject: RE: Columbia Journal of Environmental Law (field Report 2015) Finding Fault: Induced Earthquake Liability and Regulation

No I missed it! But For the training module that OGWDW wants, I was looking at various videos related to the topic. (There are a lot of non-scientific rants out there.)

National Academy: energy Technologies and Manmade Earthquakes
National Academy version: https://www.youtube.com/watch?v=Uuh9lHavdvc 11:15 min

BBC Worldwide: Does Fracking Cause Earthquakes? Bang goes the theory - Series 6 - BBC 4:07 min
https://www.youtube.com/watch?v=_E3A-D8mAb4

Other videos

AGI: Critical Issues Webinar: Induced Seismicity in the Mid-Continent 59:36 min
https://www.youtube.com/watch?v=yJyjipHjoB8

The Geological Society: Keele University: Induced Seismicity in the UK and its relevance to Shale Gas Hydraulic Stimulation 41:03 min (Prof. Peter Styles)

https://www.youtube.com/watch?v=ij9uR8vzmKg video of a slide presentation, 41:03 min (sound goes in and out as speaker walks around; picture frequently blurry)); **decades of tracking induced seismicity from mining etc.**

Monitor microseismicity' combined with fluid pressure monitoring': before, during and after
HF Traffic Light Thresholds:very low magnitudes; decrease volume injected and pressure hold time; last increase flowback days

Swiss M2.3 max level

Peak particle velocity function of local surface and does not apply elsewhere with different surface rock

IRIS EPO: Cliff Frohlich: Induced/Triggered Earthquakes: Examples from Texas
https://www.youtube.com/watch?v=mLmuwTP-xyc

Stanford: Investigation of Injection-Induced Seismicity: Assessing Earthquake Risks from Hydraulic Fracturing for Geothermal Power, Natural Bas and CO2 Storage (from PhD thesis by Mark McClure)
https://www.youtube.com/watch?v=EJgEPu5zc7s video of a slide presentation, 53:21 min

KQED QUEST HD: Induced Swismicity: Man-Made Earthquakes

https://www.youtube.com/watch?v=RDJ5ea6jNc4 The Geysers

From: Gillespie, David
Sent: Tuesday, July 21, 2015 2:56 PM
To: Dorsey, Nancy
Subject: RE: Columbia Journal of Environmental Law (field Report 2015) Finding Fault: Induced Earthquake Liability and Regulation

Excellent Nancy. I can't wait to read it. Did you happen to catch the weather channel's special last night on man-made earthquakes from fracking waste water injection? I recorded it.

David Gillespie
Office of Regional Counsel
U.S. EPA, Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733
Voice: (214) 665-7467
Facsimile: (214) 665-2182
gillespie.david@epa.gov

From: Dorsey, Nancy
Sent: Tuesday, July 21, 2015 2:27 PM
To: Dellinger, Philip; Bates, William; Hildebrandt, Kurt; Green, Holly; Gillespie, David
Cc: Lawrence, Rob; Johnson, Ken-E; Brown, Jamesr
Subject: Columbia Journal of Environmental Law (field Report 2015) Finding Fault: Induced Earthquake Liability and Regulation

Hm, David this is more your line than mine, but definetly worth being familiar with. I think the auther may have provided a lot of this data also to GWPC for their primer, but I would have to dig to verify that.

Finding Fault: Induced Earthquake Liability and Regulation
http://columbiaenvironmentallaw.org/assets/Richards_Macro_WEB_final.pdf

The article certainly has a strong States First feel: references 17-21; 37, and especially 40. Some of the references do not match the facts (See 21: not Zoback at all), or in later articles cited the original facts in case of much later reporting (85: 14 homes destroyed?????).

"Both Arkansas and Ohio imposed moratoria. This appears to be an effective deterrent, as subsequent operations have not induced earthquakes in either
state." (Not actually true.)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, July 15, 2015 9:32 AM
To: Charles Lord; Matt Skinner; Tim Baker; Patricia Downey; Jim Phelps
Cc: Brown, Jamesr
Subject: FW: earthquake article

I am sure you have seen this, but just in case…

https://www.linkedin.com/pulse/oklahoma-regulators-implement-evolving-regulatory-craig-sundstrom?trk=hp-feed-article-title-like

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, July 13, 2015 8:08 AM
To: R6 6WQ-SG; R6 6WQ-S
Subject: 4.2M in Helena, OK and 2.4M Irving, TX
Attachments: 2015-07-10 23:09:17 (M4.2) OKLAHOMA 36.7 -98.2 (63093); 2015-07-13 11:03:56 (M2.4) NORTHERN TEXAS 32.8 -96.9 (63093)

Dorsey, Nancy

From: Dellinger, Philip
Sent: Tuesday, July 07, 2015 7:57 AM
To: R6 6WQ-SG; Lawrence, Rob; Gillespie, David
Subject: FW: EARTHQUAKES: Okla. activists ask EPA to take over regulation of wastewater disposal

From: Casso, Ruben
Sent: Tuesday, July 07, 2015 7:44 AM
To: Dellinger, Philip
Subject: EARTHQUAKES: Okla. activists ask EPA to take over regulation of wastewater disposal

EARTHQUAKES: Okla. activists ask EPA to take over regulation of wastewater disposal

Mike Soraghan, E&E reporter

Published: Tuesday, July 7, 2015

Oklahoma activists are petitioning U.S. EPA to take over regulation of oil and gas wastewater disposal, saying state regulators have failed to do enough to stop the state's swarms of man-made earthquakes.

In a petition mailed last week, Tulsa petroleum geologist Bob Jackman said the Oklahoma Corporation Commission (OCC) hasn't done enough to restrict disposal under the federal Underground Injection Control (UIC) program.

"The situation in Oklahoma is urgent," the petition states, "yet the OCC continues to do too little too late to monitor, regulate, and fine UIC wells and operators within their jurisdiction that violate requirements and do damage."

Jackman, who has been making himself a thorn in the side of state officials, and Stillwater activist Angela Spotts are distributing the petition to others in the state and encouraging them to sign copies and send them to EPA. The petitions are addressed to EPA Administrator Gina McCarthy and Dallas-based Region 6 Administrator Ron Curry.

Oil and gas disposal wells are regulated under the federal Safe Drinking Water Act. But they're monitored by state oil and gas officials in states EPA has granted "primacy." In Oklahoma, the OCC oversees oil and gas disposal wells. EPA maintains some oversight of the state programs.

Favorably aligned faults and production methods that create uniquely large volumes of wastewater appear to have combined in Oklahoma to create unprecedented swarms of man-made earthquakes in several parts of the state.

Last year, the state had 585 earthquakes of magnitude 3 or greater, and this year there already have been more than 450. That compares with about two a year before 2009.

The laws that govern disposal wells do not make it illegal to cause earthquakes. But quakes are considered a potential threat to aquifers, and the law does seek to prevent pollution of drinking water.

The most recent EPA evaluation of Oklahoma's program, filed in April 2013, gave the OCC mixed reviews but made no mention of EPA taking over the program. The evaluation was obtained by *EnergyWire* through a Freedom of Information Act request.

It commended the OCC for selecting the Oklahoma Geological Survey as the "primary investigative agency" for determining the cause of the earthquakes. Records obtained by *EnergyWire* and other news outlets have indicated OGS scientists have been subject to pressure from the oil and gas industry (*EnergyWire*, July 2).

The review questioned the accuracy of some of the data the OCC had received from companies about their disposal wells.

"EPA recommends that OCC consider ways to improve the accuracy or verification of operator-reported injection information," the review said.

In particular, it pointed to potential accuracy problems with injection pressures reported for a disposal well located close to the state's largest-recorded earthquake, a magnitude-5.7 event in November 2011.

The operators of that well recently acknowledged that it was drilled too deep and applied to reduce its depth (*EnergyWire*, May 15).

EPA Region 6 spokeswoman Jennah Durant said the agency has received the petitions.

"While I can't immediately reply to the petitions, I can say that EPA carefully reviews federal programs delegated to the states to ensure they comply with federal law," Durant said.

The OCC did not immediately respond to requests for comment.

Click here to see the activists' petition to EPA.

Click here to see EPA's evaluation of Oklahoma's regulatory program.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, July 02, 2015 10:05 AM
To: Ben Grunewald (ben@gwpc.org)
Subject: FW: Oklahoma Supreme Court clears way for earthquake lawsuits against energy companies

Oklahoma Supreme Court clears way for earthquake lawsuits against energy companies

An attorney is seeking class-action status covering nine counties in a lawsuit filed by a Prague woman.

Posted: Wednesday, July 1, 2015 12:00 am

By RANDY KREHBIEL World Staff Writer | 10 comments

OKLAHOMA CITY — The state Supreme Court cleared the way Tuesday for lawsuits against two Tulsa-area companies that plaintiffs say are responsible for earthquakes that have shaken central Oklahoma since late 2011.

In a 7-0 decision with two justices not participating, the court ruled that Sandra Ladra of Prague may seek damages in district court for injuries she received during an earthquake on the night of Nov. 5, 2011.

By extension, the Supreme Court ruling also allows a property damage suit filed by Jennifer L. Cooper of Prague to go forward. The case potentially is worth tens of millions of dollars if the requested class-action status is granted. Both cases are in Lincoln County District Court and are brought by the same attorneys.

Ladra is suing New Dominion LLC of Tulsa and Spess Oil Co. of Cleveland, Oklahoma, claiming that their high-pressure disposal wells are responsible for the earthquake during which she was injured. Cooper is suing the same two companies in the potential class-action suit.

The Oklahoma Emergency Management Agency said six houses were destroyed and 172 others were damaged when three quakes of 5.0 magnitude or greater struck the Prague area from Nov. 5 to 8, 2011.

Cooper's suit seeks class-action status for residents with property damaged by earthquakes in Lincoln, Payne, Logan, Oklahoma, Cleveland, Pottawatomie, Seminole, Okfuskee and Creek counties. The suit states that the class would consist of people in those counties who have owned homes or business properties since Nov. 5, 2011.

The suit states that Cooper's home sustained more than $100,000 in damage from the 2011 Prague earthquakes. She bought the home in 2010 for $117,000 and had spent about $15,000 improving it, the suit states.

Attorneys for New Dominion and Spess argued that the Oklahoma Corporation Commission, not the court system, was the proper venue for damage claims because the commission has sole authority over oil and gas operations.

The state Supreme Court disagreed.

“Allowing district courts to have jurisdiction in these types of private matters does not exercise inappropriate ‘oversight and control’ over the (Corporation Commission),” says the opinion, written by Justice James Winchester. “Rather, it conforms to the long-held rule that district courts have exclusive jurisdiction over private tort actions when regulated oil and gas operations are at issue.”

“My clients are very happy,” said Scott Poynter, the plaintiffs’ lead attorney in both lawsuits. “The court decision is what we’ve been saying all along.”

Poynter, of Little Rock, Arkansas, previously filed suit on behalf of eight central Arkansas property owners who said their homes were damaged by injection well-induced earthquakes. That suit was settled out of court.

Attorneys for New Dominion did not respond to a request for comment on Tuesday.

Oklahoma has gone from virtually no discernible earthquakes a few years ago to more than any other state. Some scientific studies have linked high-pressure injection wells such as those operated by New Dominion and Spess to the increased seismic activity.

Recent news reports have suggested that some leaders in the oil and gas industry tried to suppress findings by the Oklahoma Geological Survey supporting this view.

The University of Oklahoma, which administers the Oklahoma Geological Survey, has denied any such interference, but emails obtained by the Tulsa World and others indicate that some industry leaders made known their displeasure with the agency.

Also, at least one email indicates that state regulators became upset in 2013 when they learned that an OU researcher was about to publish an academic journal article bolstering the disposal-well theory.

Disposal wells, as the name implies, are used to dispose of water and other liquids that are byproducts of oil and gas production. Oklahoma has thousands of such wells, but only a few are thought to have the capacity to create noticeable seismic activity.

Randy Krehbiel 918-581-8365

randy.krehbiel@tulsaworld.com

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, June 22, 2015 8:36 AM
To: Tim Baker; Matt Skinner; Charles Lord; Patricia Downey
Cc: Dellinger, Philip
Subject: FW: two NEW postings a IS
Attachments: Weingarten et al Science with Supplemental.pdf; Walsh and Zoback Science Advances Final.pdf

Importance: High

(Colors added)

MANAGING INJECTION-RELATED SEISMIC RISKS – from Walsh and Zoback
Injection of large volumes of saltwater into the Arbuckle group appears to be triggering the release of already stored strain energy in crystalline basement. It would seem logical that reducing the volume of injected saltwater into the Arbuckle should reduce the amount of triggered seismicity. In addition, as shown by the areas with many EOR wells recycling produced water in producing horizons, reinjection of the saltwater into the horizons that produced the water and oil would not be expected to trigger seismicity. Thus, the feasibility of injecting the large volumes of produced water back into depleted portions of the producing reservoirs needs to be investigated.

In a recent study of the Jones earthquakes (30), it was argued that four large-scale injectors (two of which were injecting more than 1 million barrels/month) located just southeast of Oklahoma City are the principal cause of the Jones seismicity, much of which is located over 10 km from the injectors. In the three study areas where SWD injection and seismicity have increased, the few SWD wells injecting unusually large volumes (for example, more than 400,000 barrels/month) contribute a relatively small fraction of the total SWD volume in those areas (21% in Cherokee, 19% in Perry, and 45% in Jones; see fig. S2). Thus, whereas reducing the cumulative volume of SWD should be beneficial, establishing an arbitrary upper limit to injection rates of any single well may not reduce the probability of triggering seismicity if the same volume was to be injected in a number of lower-rate wells nearby.

Without detailed modeling, it is difficult to predict how restricting or more broadly distributing the injection volumes in the study areas would affect seismicity. It is likely that even if injection from

many wells were to stop immediately, seismicity would continue as pressure continues to spread out from past injection. Over time, of course, one would expect seismicity to diminish if the aggregate rate of injection in the seismically active areas were to significantly decrease. As the seismicity rate in Oklahoma a decade ago was similar to the historical rate, there may be some rate of injection that can be accommodated by the regional hydrologic system without generating the pressure increases responsible for seismicity.
To date, there have been two published modeling studies relevant to Oklahoma seismicity (24, 30). In both, it was argued that small pressure perturbations could propagate laterally within the disposal zone for 10 km or more, before triggering slip on critically stressed faults in the basement. However, with little constraint of subsurface hydrologic properties such as porosity, permeability, and pore pressure (and its variations with time), it is difficult to use models to make reliable predictions. A concerted effort of systematic data collection is needed to better constrain hydrologic models to devise strategies for modifying injection practices to reduce the probability of triggered seismicity.

It would be helpful to evaluate if there is stratigraphic control on the tendency for SWD into particular wells or zones to trigger seismicity. The importance of a bottom-sealing layer to prevent pressurization of basement faults has been pointed out in a generic modeling study (24). Injection into aquifers that are physically separated from crystalline basement by relatively impermeable formations would be beneficial as would avoiding pressurization near potentially active faults (2). Combining subsurface fault data with information about the stress field permits identification of which faults are critically stressed and to be avoided.

It has been suggested that the largest earthquake in an area correlates with the total injected volume in the area (27). However, in the context of triggered seismicity, the largest earthquake that might be triggered is determined by preexisting geologic conditions, not the magnitude of the perturbation of pore pressure. It is also clear that greatly improved earthquake monitoring and real-time analysis would be helpful to assess changes in seismic hazard with time. Determination of accurate earthquake locations (especially earthquake depth) requires relatively dense seismic networks. Real-time analysis of earthquake locations and the style of faulting can be used to identify potentially hazardous situations, such as earthquakes aligning along basement faults that could be large enough to cause a potentially damaging earthquake.

From: Ben Grunewald [mailto:ben@gwpc.org]
Sent: Friday, June 19, 2015 2:40 PM
To: Mike Nickolaus; Andrew.adgate@dnr.state.oh.us; sanderson@edf.org; darthur@all-llc.com; Scott.ausbrooks@arkansas.gov; Brad.Bacon@pdce.com; t.baker@occemail.com; gerry.baker@iogcc.state.ok.us; Bates, William; rabauer@illinois.edu; johnbaza@utah.gov; Larry.Bengal@aogc.state.ar.us; beroza@stanford.edu; bromhal@netl.doe.gov; rex@kgs.ku.edu; jeff.bull@chk.com; Diana.burn@stata.co.us; ccabarcas@hilcorp.com; tcladouhos@altarockenergy.com; dustin.crandall@netl.doe.gov; Dellinger, Philip; tdohmen@hess.com; Dorsey, Nancy; Jon.freedman@ge.com; cliff@ig.utexas.edu; Rod.Gertson@dvn.com; Green, Holly; rob.habiger@spectraseis.com; Henry.J.Harmon@wv.gov; dhenry@hilcorp.com; r.hoffman@kcc.ks.gov; austin.holland@ou.edu; roger.kelley@clr.com; Kenney, James; bob.koehler@state.co.us; Joslee.jjl@gmail.com; C.Lord@occemail.com; Hal.Macartney@pxd.com; elmajer@lbl.gov; shawn.maxwell@itasca-image.com; hmcdivitt@dnr.IN.gov; lmcdonald@sandridgeenergy.com; m[redacted]adows@api.org; musick_ambrose@msn.com; Mark.Nechodom@conservation.ca.gov; tnein@hilcorp.com; J(b) (6) [redacted]; kris.j.nygaard@exxonmobil.com; Mike Paque; john.parrish@conservation.ca.gov; DonaldPA@USC.edu; wrish@hullinc.com; johnrogers@utah.gov; brian.rovelli@ge.com; jrubinstein@usgs.gov; rupp@indiana.edu; rjsa@chevron.com; Jesse.sandlin@dnv.com; Leslie.Savage@rrc.state.tx.us; fernando.sierra@shell.com; Rick.Simmers@dnr.state.oh.us; Michael.sims@rrc.state.tx.us; dsmith@rexenergycorp.com; jsmith@anga.us; Edward.steele1@ge.com; stump@smu.edu; LauraSwafford@chevron.com; Michael.Teague@ee.ok.gov; Mark.thiesse@wyo.gov; Timothy_Tyrrell@xtoenergy.com; (b) (6) [redacted] john@veilenvironmental.com; randijwalters@gmail.com; norm.warpinski@pinntech.com; Kara.williams@chk.com; jonathan.winsor@shell.com; Ivan.Wong@urs.com; brian.woodard2@chk.com; robert.worstall@dnr.state.oh.us; Debby.yost@chk.com; Ulrich.Zimmer@shell.com; zoback@stanford.edu; craig.pearson@rrc.state.tx.us; jfurnace@hilcorp.com; michael.mathis@clr.com; jill.cooper@Anadarko.com; m.skinner@occemail.com; Diana.Burn@state.co.us; Jesse.Sandlin@dvn.com
Cc: Mike Paque; Dan Yates; Gerry Baker; Leslie Savage; Matt Kellogg
Subject: RE: two NEW postings a IS

See reports attached and at…
http://www.gwpc.org/resources/induced-seismicity-resources

THANKS!
Ben Grunewald
405 516 4972

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, June 17, 2015 3:02 PM
To: R6 6WQ-SG
Subject: Fw: 2015-06-14 18:17:08 (M4.3) OKLAHOMA 36.3 -97.5 (63093)

Todays 4+ followed Sunday's!

From: USGS ENS
Sent: Sunday, June 14, 2015 1:29 PM
To: Dorsey, Nancy
Subject: 2015-06-14 18:17:08 (M4.3) OKLAHOMA 36.3 -97.5 (63093)

M4.3 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.3
Date-Time	14 Jun 2015 18:17:08 UTC 14 Jun 2015 13:17:09 near epicenter 14 Jun 2015 11:17:08 standard time in your timezone
Location	36.287N 97.523W
Depth	5 km
Distances	21 km (13 mi) W of Perry, Oklahoma 34 km (21 mi) ESE of Enid, Oklahoma 45 km (28 mi) WNW of Stillwater, Oklahoma 46 km (29 mi) N of Guthrie, Oklahoma 90 km (56 mi) N of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 1.3 km; Vertical 2.0 km
Parameters	Nph = 51; Dmin = 48.2 km; Rmss = 0.33 seconds; Gp = 61° Version =
Event ID	us 20002prt

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program

Disclaimer

This email was sent to dorsey.nancy@epa.gov

You requested mail for events within the 'R6 plus CO' region
for M1.0 between 08:00 and 20:00 and M1.5 other times.

To change your parameters, go to:

https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, June 17, 2015 1:27 PM
To: Charles Lord; Tim Baker; Matt Skinner
Subject: oklahoma earthquakes set to synthesizer chimes

5 - Power Struggle: The Oil and Gas Boom and an Outbreak of Earthquakes in Oklahoma, NPR StateImpact, 6/16/15

http://stateimpact.npr.org/oklahoma/2015/06/15/power-struggle-the-oil-and-gas-boom-and-an-outbreak-of-earthquakes-in-oklahoma/

Reveal's Michael Corey and Joe Wertz of StateImpact Oklahoma hop in a car and drive toward the epicenter of two earthquakes that had just struck near the town of Guthrie, Oklahoma, to see the after-effects for themselves and talk to the people who live in the area. Are residents troubled by or numb to the earthquakes?

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, June 16, 2015 9:00 AM
To: Lawrence, Rob
Subject: RE: Myths & Facts on Wastewater Injection, HF, EOR, and Induced Seismicity

Justin sent me a copy if you need it.

FYI, this link did not work for me.

From: Dellinger, Philip
Sent: Tuesday, June 16, 2015 6:50 AM
To: R6 6WQ-SG
Subject: FW: Myths & Facts on Wastewater Injection, HF, EOR, and Induced Seismicity

fyi

From: Lawrence, Rob
Sent: Tuesday, June 16, 2015 2:39 AM
To: Overbay, Michael; Dellinger, Philip
Subject: Fwd: Myths & Facts on Wastewater Injection, HF, EOR, and Induced Seismicity

Sent from my iPhone

Begin forwarded message:

> **From:** "Beeler, Cindy" <Beeler.Cindy@epa.gov>
> **Date:** June 15, 2015 at 9:31:36 PM GMT+2
> **To:** "Minter, Douglas" <Minter.Douglas@epa.gov>, "Roberts, Sarah" <Roberts.Sarah@epa.gov>, "Lawrence, Rob" <Lawrence.Rob@epa.gov>
> **Cc:** "Frederick, Lydia" <Frederick.Lydia@epa.gov>
> **Subject: Myths & Facts on Wastewater Injection, HF, EOR, and Induced Seismicity**
>
> USGS Report just out … link below – thanks to our responsive and helpful R8 Library Team!
>
> **Cindy Beeler**
> US EPA Region 8, Energy Advisor
> Office of the Regional Administrator
> Tel: 303-312-6204
> Beeler.Cindy@epa.gov
>
> **C.e.l.e.b.r.a.t.e P.r.i.d.e**
> **June 22-26**

watch the video|sign the pledge|be an ally

From: Frederick, Lydia
Sent: Monday, June 15, 2015 11:28 AM
To: Beeler, Cindy
Subject: RE: Obtain copy of Induced Seismicity Report
Importance: High

Cindy,

Here's a link to the pdf.

https://profile.usgs.gov/myscience/upload_folder/ci2015Jun1012005755600Induced_EQs_Review.pdf

Even though it says at the top "SRL early edition", I think this pdf is the same as the one listed on the SRL website you provided. If you'd like me to get a copy from SRL, please let me know. We can request it from another library through interlibrary loan.

Please tell us how we're doing - rate our customer service!
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lydia
****
Lydia G Frederick, MLS
Supervisory Librarian (Contractor, ASRC Primus)

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(w) 303-312-6743

"If you have knowledge, let others light their candles at it." ascribed to Margaret Fuller (May 23, 1810 - July 19, 1850), American journalist

---

From: Beeler, Cindy
Sent: Friday, June 12, 2015 8:03 AM
To: Frederick, Lydia
Subject: Obtain copy of Induced Seismicity Report

Hi Lydia –

Would you all be able to access the following report? I tried but was prompted for member sign-in or purchase option.

Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity
1. Justin L. Rubinstein-a
2. Alireza Babaie Mahani-b
1. aU.S. Geological Survey, Menlo Park, California 94025 U.S.A. jrubinstein@usgs.gov
2. bPacific Geoscience Center, Geological Survey of Canada, Sidney, British Colombia, Canada V8L 5T5

http://srl.geoscienceworld.org/content/early/2015/06/05/0220150067.full.pdf

Seismological Research Letters, July/August 2015, First published on June 10, 2015,

Thanks,

Cindy Beeler
US EPA Region 8, Energy Advisor
Office of the Regional Administrator
Tel: 303-312-6204
Beeler.Cindy@epa.gov

C.e.l.e.b.r.a.t.e P.r.i.d.e
June 22-26
watch the video|sign the pledge|be an ally

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, June 15, 2015 9:25 AM
To: Charles Lord; Jim Marlatt
Subject: FW: SRL abstracts

Another induced seismicity focus series.

From: Dorsey, Nancy
Sent: Monday, June 15, 2015 9:12 AM
To: Green, Holly
Cc: Dellinger, Philip; Bates, William; Hildebrandt, Kurt; Johnson, Ken-E
Subject: SRL abstracts

Actually, here is the free bits you can access through
http://www.opengeosci.org/#search=&zoom=2&center=30,0&source=&category=&area=&type=undefined&areadata=points&dates=

Preface to the Focus Section on Injection-Induced Seismicity

1. **David W. Eatona and**
2. **Justin L. Rubinsteinb**

+ Author Affiliations

1. [a] eatond@ucalgary.ca
2. [b] jrubinstein@usgs.gov

The ongoing, dramatic increase in seismicity in the central United States that began in 2009 is believed to be the result of injection-induced seismicity (Ellsworth, 2013). Although the basic mechanism for activation of slip on a fault by subsurface fluid injection is well established (Healy *et al.*, 1968; Raleigh *et al.*, 1976; Nicholson and Wesson, 1992; McGarr *et al.*, 2002; Ellsworth, 2013), the occurrence of damaging $M \geq 5$ earthquakes and the dramatic increase in seismicity in the central United States has brought heightened attention to this issue. The elevated seismicity is confined to a limited number of areas, and accumulating evidence indicates that the seismicity in these locations is directly linked to nearby industrial operations. This *Seismological Research Letters* (*SRL*) focus section presents a selected set of seven technical papers that cover various aspects of this topic, including basic seismological and ground-motion observations, case studies, numerical simulation of fault activation, and risk mitigation.

Rubinstein and Babaie Mahani (2015) provide a primer on fluid injection and induced seismicity with an intended audience spanning the public, media, industry, and academic scientists. They describe the fluid injection processes used by the oil and gas industry, the underlying physical mechanisms for induced seismicity, and several widespread misconceptions about these processes and their relationships to hydraulic fracturing. Within the oil and gas industry, processes that involve large-volume fluid injection into the subsurface include: (1) wastewater injection that involves long-term disposal of brines that are coproduced with oil; (2) hydraulic fracturing that involves injection …

Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity

1. Justin L. Rubinstein and

2. Alireza Babaie Mahani

1. [a]U.S. Geological Survey, Menlo Park, California 94025 U.S.A. jrubinstein@usgs.gov
2. [b]Pacific Geoscience Center, Geological Survey of Canada, Sidney, British Colombia, Canada V8L 5T5

INTRODUCTION

The central United States has undergone a dramatic increase in seismicity over the past 6 years (Fig. 1), rising from an average of 24 M≥3 earthquakes per year in the years 1973–2008 to an average of 193 M≥3 earthquakes in 2009–2014, with 688 occurring in 2014 alone. Multiple damaging earthquakes have occurred during this increase including the 2011 **M** 5.6 Prague, Oklahoma, earthquake; the 2011 **M** 5.3 Trinidad, Colorado, earthquake; and the 2011 **M** 4.7 Guy-Greenbrier, Arkansas, earthquake. The increased seismicity is limited to a few areas and the evidence is mounting that the seismicity in many of these locations is induced by the deep injection of fluids from nearby oil and gas operations. Earthquakes that are caused by human activities are known as induced earthquakes. Most injection operations, though, do not appear to induce earthquakes. Although the message that these earthquakes are induced by fluid injection related to oil and gas production has been communicated clearly, there remains confusion in the popular press beyond this basic level of understanding.

Figure 1.

Count of M≥3 earthquakes in the central and eastern United States from 1973 to April 2015. Two abrupt increases in the earthquake rate occurred in 2009 and 2013. (Inset) Spatial distribution of earthquakes. Red dots represent earthquakes that occurred between 2009 and April 2015, and blue dots represent earthquakes that occurred between 1973 and 2008. Red color becomes brighter when there are more earthquakes in the area. The earthquake rate and distribution of earthquakes changed in 2009. Prior to 2009, earthquakes were spread across the United States. Beginning in 2009 the earthquakes are tightly clustered in a few areas (central Oklahoma, southern Kansas, central Arkansas, southeastern Colorado and northeastern New Mexico, and multiple parts of Texas).

In this article, we attempt to dispel the confusion for a nonspecialist audience. First, …

Selected Abstracts

Characterizing and Responding to Seismic Risk Associated with Earthquakes Potentially Triggered by Fluid Disposal and Hydraulic Fracturing

1. Randi Jean Walters,
2. Mark D. Zoback,
3. Jack W. Baker and
4. Gregory C. Beroza

1. [a]Department of Geophysics, Stanford University, 397 Panama Mall B59, Stanford, California 94305 U.S.A walters1@stanford.edu
2. [b]Department of Geophysics, Stanford University, 397 Panama Mall Room 347, Stanford, California 94305 U.S.A
3. [c]Department of Civil and Environmental Engineering, Stanford University, 473 Via Ortega Room 283, Stanford, California 94305 U.S.A
4. [d]Department of Geophysics, Stanford University, 397 Panama Mall Room 355, Stanford, California 94305 U.S.A

INTRODUCTION AND CONTEXT

For nearly a century, earthquakes apparently triggered by fluid injection have been observed in many parts of the world (National Research Council [NRC], 2012). Although injection-related seismicity is a well-known phenomenon, recent years have seen a dramatic increase in earthquake occurrence apparently associated with oil and gas development. This increase has been most notable in the central and eastern United States (Ellsworth, 2013). Recent occurrences of felt events in areas of significant populations have brought attention to this issue from the public, oil and gas operators, regulators, and academics.

Though fluid disposal and hydraulic fracturing both have the potential to trigger earthquakes, it has become clear that the potential for induced seismicity is higher for fluid (usually saltwater) disposal than for hydraulic fracturing. For instance, saltwater disposal involves very long injection times (years to decades) and very large injection volumes (often thousands to tens of thousands of m^3 per day). This leads to much more extensive pressure perturbations than hydraulic fracturing operations, in which 1000 m^3 might be injected over an ~2 hr period. The inherent differences in injection practices between these two different types of fluid-injection operations, and the apparent differences in the potential for triggering earthquakes, mean that appropriate procedures for risk assessment associated with each of these two types of fluid injection need to be developed, as described below. In this work, we focus our discussions on saltwater disposal and hydraulic fracturing, though the concepts presented can be generally applied to other types of fluid disposal.

The primary physical processes responsible for injection-related seismicity are generally well known (see reviews by Suckale, 2009; NRC, 2012). Simply put, the normal effective stress resists fault slip by acting perpendicular to a fault, essentially clamping it shut. As pore pressure increases, the effective normal stress on a fault is …

Focal Mechanisms of Some Inferred Induced Earthquakes in Alberta, Canada

1. David W. Eaton and
2. Alireza Babaie Mahani

1. *Department of Geoscience, University of Calgary, Calgary, Alberta, Canada T2N 1N4* eatond@ucalgary.ca

INTRODUCTION

Although it has long been understood that injection of fluids into the subsurface can activate slip on a fault (e.g., Healy *et al.*, 1968), seismicity induced by fluid injection associated with oil and gas operations has recently come into sharper focus (Ellsworth, 2013; Keranen *et al.*, 2013; Schultz *et al.*, 2014). Since December 2013, anomalous seismicity of magnitude up to M_L 4.4 has occurred episodically in parts of Alberta, Canada. In the Crooked Lake (CL) area of west-central Alberta, induced seismicity appears to be spatially and temporally correlated with hydraulic fracturing, a process of injecting fracturing fluids into a rock formation at a force exceeding the fracture pressure of the rock, thus inducing a network of fractures through which oil or natural gas can flow to the wellbore (CCA, 2014). Farther south, an M_w 3.8 earthquake on 9 August 2014 occurred within the Rocky Mountain House (RMH) cluster, an area where persistent seismic activity since the late 1970s has been interpreted to be triggered by poroelastic stress changes from the production of hydrocarbons (Baranova *et al.*, 1999). This recent earthquake is the largest event that has occurred to date within this cluster (Stern *et al.*, 2013), representing a significant departure from a trend of declining seismicity for the past three decades.
In this article, we investigate focal mechanisms for some events that have occurred in Alberta since December 2013. These focal solutions were obtained using the polarity of *P*-wave first motions registered on regional seismograms. This investigation was facilitated by the installation of numerous seismograph stations in Alberta during the past few years (Schultz *et al.*, 2015), including the Regional Alberta Observatory for Earthquake Studies Network (RAVEN). For the purpose of this study, a crustal velocity model was developed based on sonic log data from …

Surface Monitoring of Microseismicity at the Decatur, Illinois, CO_2 Sequestration Demonstration Site

1. J. O. Kaven,
2. S. H. Hickman,
3. A. F. McGarr and
4. W. L. Ellsworth

1. *USGS Earthquake Science Center, Menlo Park, California 94025 U.S.A.* okaven@usgs.gov

INTRODUCTION

Sequestration of CO_2 into subsurface reservoirs can play an important role in limiting future emission of CO_2 into the atmosphere (e.g., Benson and Cole, 2008). For geologic sequestration to become a viable option to reduce greenhouse gas emissions, large-volume injection of supercritical CO_2 into deep sedimentary formations is required. These formations offer large pore volumes and good pore connectivity and are abundant (Bachu, 2003; U.S. Geological Survey Geologic Carbon Dioxide Storage Resources Assessment Team, 2013). However, hazards associated with injection of CO_2 into deep formations require evaluation before widespread sequestration can be adopted safely (Zoback and Gorelick, 2012). One of these hazards is the potential to induce seismicity on pre-existing faults or fractures. If these faults or fractures are large and critically stressed, seismic events can occur with magnitudes large enough to pose a hazard to surface installations and, possibly more critical, the seal integrity of the cap rock.
The Decatur, Illinois, carbon capture and storage (CCS) demonstration site is the first, and to date, only CCS project in the United States that injects a large volume of supercritical CO_2 into a regionally extensive, undisturbed saline formation. The first phase of the Decatur CCS project was completed in November 2014 after injecting a million metric tons of supercritical CO_2 over three years. This phase was led by the Illinois State Geological Survey (ISGS) and included seismic monitoring using deep borehole sensors, with a few sensors installed within the injection horizon. Although the deep borehole network provides a more comprehensive seismic catalog than is presented in this paper, these deep data are not publically available. We contend that for monitoring induced microseismicity as a possible seismic hazard and to elucidate the general patterns of microseismicity, the U.S. Geological Survey (USGS) surface and shallow borehole …

Could the IMS Infrasound Stations Support a Global Network of Small Aperture Seismic Arrays?

1. Steven J. Gibbons,
2. Tormod Kværna and

3. Svein Mykkeltveit

1. *NORSAR, PO Box 53, N2027 Kjeller, Norway steven@norsar.no*

INTRODUCTION

The monitoring of earthquakes and underground explosions worldwide is performed using networks of seismic stations. The vast majority of these stations consist of three mutually orthogonal sensors, one vertical and two horizontal, at a single site. Seismic signals are detected on individual stations, and events are then defined and located by associating the signals recorded on many different stations. Some networks are global (e.g., Romanowicz and Giardini, 2001; Ammon *et al.*, 2010), and there are increasingly many national and regional networks that, with increasing available computational power and decreasing data transmission and storage costs, are continually becoming denser. This is particularly the case for highly populated regions with significant and destructive seismicity, such as Japan (e.g., Okada *et al.*, 2004). Networks such as the USArray (Levander *et al.*, 1999) and GLISN (Clinton *et al.*, 2014) can comprise both permanent and temporary stations, covering vast regions (usually over a limited time span) to glean information about structure and geophysical processes. It is, however, still the case that large regions of Earth have very poor coverage of permanent seismic stations.
Seismic arrays are a special class of seismic station consisting of seismometers at numerous closely spaced sites (usually within an aperture of a few kilometers) such that signal detection and parameter estimation are greatly enhanced by coherently processing the waveforms at the different sites. Progress in seismic array technology was driven largely by the need to monitor underground nuclear weapons testing (e.g., Douglas, 2002), because the events being monitored by any one country were taking place in the territory of another country and it became imperative to be able to detect and correctly identify a weak seismic signal generated by a remote explosion. With the opening for signing of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) in 1996 (Dahlman *et al.*, 2009, …

Modeling Injection-Induced Seismicity with the Physics-Based Earthquake Simulator RSQSim

1. James H. Dieterich,
2. Keith B. Richards-Dinger and
3. Kayla A. Kroll

1. *Department of Earth Sciences, University of California, 900 University Avenue, Riverside, California 92521 U.S.A. keithrd@ucr.edu*

INTRODUCTION

Although the phenomenon of earthquakes induced by the subsurface injection of fluids has been recognized, and the basic mechanisms understood, for many decades (e.g., Healy *et al.*, 1968), the recent increase in seismicity associated with oil and gas development, including large damaging events (e.g., Ellsworth, 2013; Keranen *et al.*, 2013; Hough, 2014; Rubinstein *et al.*, 2014) makes clear the need to better understand the processes controlling such seismicity and to develop techniques to mitigate the associated seismic hazard.
The relationship of fault stress, fault strength, and fluid pressure at the onset of fault slip in the most basic form is given by the modified Coulomb criterion, (1)in which τ and σ are the shear and normal stress, respectively, acting on the fault surface, P is the pore-fluid pressure, and μ is the coefficient of fault friction. The term $(\sigma-P)$ is the effective normal stress (Terzaghi, 1925). From equation (1), a fault can be brought to a critical state through an increase of shear stress τ, a decrease of the normal stress σ, an increase of fluid pressure P, or some combination of the three. Increase of pore-fluid pressure is the most widely cited cause of earthquakes induced by human activities (National Research Council, 2012). Consequently, investigations and models of induced seismicity have tended to focus mainly on spatial changes of fluid pressures (Hsieh and Bredehoeft, 1981; Shapiro and Dinske, 2009).
Although the immediate cause of injection-induced earthquakes is the increase of fluid pressure that brings a fault to a critical stress state, models of the spatial changes of fluid pressure alone are insufficient to either predict or understand the space–time characteristics of induced earthquakes. Comprehensive system-level models that couple physics-based simulations of seismicity with reservoir simulations of fluid …

Total Probability Theorem Versus Shakeability: A Comparison between Two Seismic-Hazard Approaches Used in Central Asia

1. D. Bindi and
2. S. Parolai

1. *Deutsches GeoForschungsZentrum (GFZ), Helmholtzstrasse 7, 14467 Potsdam, Germany bindi@gfz-potsdam.de parolai@gfz-potsdam.de*

INTRODUCTION

The comparison of seismic-hazard maps produced in different countries, or computed for the same country but at different times, is often hampered by the difficulties encountered in properly accounting for the differences among the implemented methodologies. An example of such difficulty is given by the comparison between the hazard maps computed during the Cold War period for the former Soviet Union, which includes vast regions exposed to high seismic hazard (e.g., the central Asian countries and the Caucasus region), and recent assessments carried out for the same regions following approaches developed in Western countries (e.g., Ullah *et al.*, 2015). These comparisons should take into account the differences in the underlying methodologies used in the former Soviet Union and, in several cases, still in use. In the Western countries, the process of formalizing the seismic-hazard assessment within a probabilistic framework (probabilistic seismic-hazard assessment [PSHA]) was developed during the 1960s at the Universidad Nacional Autonoma de Mexico (UNAM) and at the Massachusetts Institute of Technology (MIT) (Rosenblueth, 1964; Esteva, 1967, 1968, 1970; Cornell, 1968). With the works of Cornell (1971) and Merz and Cornell (1973), PSHA was finally formalized within the context of the total probability theorem, which accounted for ground-motion variability, and its use then became widespread through the implementation and dissemination of the EQRISK software (McGuire, 1976). A comprehensive review of the early development of PSHA can be found in Bommer and Abrahamson (2006) and in McGuire (2008). On the other hand, the development of a probabilistic framework for seismic-hazard assessment in the former Soviet Union (hereinafter referred to as the USSR [Union of Soviet Socialist Republics]) was initiated in the 1940s with the works of Medvedev (1947) and developed by Riznichenko in the 1960s (e.g., Riznichenko, 1965, 1992). To quantitatively represent the …

Monitoring the Earthquake Activity in an Area with Shale Gas Potential in Southeastern New Brunswick, Canada

1. Maurice Lamontagne,
2. Denis Lavoie,
3. Shutian Ma,
4. Kenneth B. S. Burke and
5. Ian Bastow

1. [a]*Geological Survey of Canada, 615 Booth Street, Ottawa, Ontario, Canada K1A 0E9* *maurice.lamontagne@nrcan-rncan.gc.ca*
2. [b]*Geological Survey of Canada, 490 de la Couronne, Québec City, Québec, Canada G1K 9A9*
3. [c]*Department of Earth Sciences, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario, Canada K1S 5B6*
4. [d]*Department of Earth Sciences, University of New Brunswick, Fredericton, New Brunswick, Canada E3B 5H5*
5. [e]*Imperial College, London SW7 2AZ, United Kingdom*

Online Material: Lists of earthquake locations and focal depths in the vicinity of the Stoney Creek Oil and Gas Field, interpretation of sonic log of velocities, velocity model, and events used in the velocity inversion.

INTRODUCTION

In recent years, there has been much interest in seismicity induced by hydrocarbon operations (e.g., Jones *et al.*, 2014). In the United States, it is mainly the reinjection of waste water that caused a major increase in the number of recorded earthquakes (Ellsworth, 2013). In contrast, lower magnitude earthquakes induced by hydraulic fracturing (HF) of tight reservoirs has attracted less interest. However, HF in western Canada has been associated with earthquakes of moderate magnitudes and more frequent occurrences. Three magnitude 3.5–3.6 events occurred in northeast British Columbia in 2010–2011 and a magnitude 4.4 in northern Alberta in January 2015. Both regions were only weakly seismic prior to the start of HF operations (see other articles in this issue; BC Oil and Gas Commission, 2012).

In eastern Canada, HF for shale gas has occurred only at an exploratory-scale in Quebec and New Brunswick. In the St. Lawrence Valley, multistage, slickwater HF of the Utica shale was done in 19 of the 29 wells drilled (Lavoie *et al.*, 2014). During that time period, very few earthquakes were detected in the surrounding areas. Although some of these earthquakes were shallow and within 10 km of wells, the hundreds of days between HF and the earthquakes rendered a causative link unlikely (Lamontagne and Ma, 2014). Since 2009, some HF has been conducted in southeast New Brunswick and is the topic of this article.

In many areas worldwide, natural seismicity is only recorded at regional distances before hydraulic activity started. For example, in northeast British Columbia, the Canadian National Seismograph Network had very sparse coverage before mid-2013, years after HF …

Preliminary Evaluation of Ground Motions from Earthquakes in Alberta

1. Mark Novakovic and
2. Gail M. Atkinson

1. *Department of Earth Sciences, Western University, London, Ontario, Canada N6G 2V4* *mnovako3@uwo.ca* *gmatkinson@aol.com*

INTRODUCTION

Between 9 September 2013 and 22 January 2015, more than 900 seismic events in local magnitude (M_L) range 1–4 were detected and located in near-real time by the new TransAlta/Nanometrics network in western Alberta, which commenced operation in the fall of 2013. The network comprises 27 three-component broadband seismograph stations, located as shown in Figure 1, which act in cooperation with other real-time seismograph stations operated by the Alberta Geological Survey (AGS) (Stern *et al.*, 2011) and the Geological Survey of Canada (GSC). There are additional campaign-mode stations in the Canadian Rockies and Alberta Network (CRANE) network operated by the University of Alberta (Gu *et al.*, 2011).

Figure 1.

Locations of stations and study events in Alberta. Events that are considered to be blasts are designated by an x within the magnitude symbol. Note that the deformation front that marks the boundary of the Rocky Mountains is distinguishable by topography.

In this study, we compile and analyze a ground-motion database of 5% damped pseudospectral acceleration (PSA) from the signals recorded on the TransAlta/Nanometrics stations in order to gain an initial understanding of overall ground-motion source, attenuation, and site characteristics in the region. A catalog of events is provided on www.inducedseismicity.ca (last accessed May 2015); the locations and initial magnitudes of events were obtained by Nanometrics (www.nanometrics.ca; last accessed May 2015). We processed the recorded time series as described in Assatourians and Atkinson (2010). Briefly, the velocity time series are corrected for glitches and trends, then filtered and corrected for instrument response in the frequency domain. Differentiation to generate acceleration time series is done in the frequency domain before conversion back to the time domain. Horizontal and vertical peak ground velocity and peak ground acceleration values are computed from peak amplitudes of instrument-corrected time series, and 5% damped …

From: Green, Holly
Sent: Monday, June 15, 2015 8:52 AM
To: Dorsey, Nancy
Cc: Dellinger, Philip; Bates, William
Subject: RE: relocated Oklahoma events

Thanks, Nancy!

Holly Sage Green
Acting Chief, Prevention Branch
EPA Office of Ground Water and Drinking Water
1200 Pennsylvania Ave. NW, Washington, DC 20460
(202) 566-0651

From: Dorsey, Nancy
Sent: Monday, June 15, 2015 9:37 AM
To: Green, Holly; Dellinger, Philip; Hildebrandt, Kurt
Subject: FW: relocated Oklahoma events

Justin's article is probably related to the article by Ellsworth and company attached.

From: Bill Ellsworth [mailto:ellsworth@usgs.gov]
Sent: Tuesday, June 09, 2015 7:08 PM
To: Dorsey, Nancy
Subject: RE: relocated Oklahoma events

Hi Nancy,

Thanks for your interest in our TLE paper. I apologize for taking this long to get it to you, as your e-mail slipped by me when I was meeting with the RRC in Austin last Friday.

The catalog we used for this paper is just the base catalog used to make the 2014 National Seismic Hazard Model. I don't know about relocated earthquakes in Oklahoma, but you might contact Dan McNamara about the earthquake relocations from his TLE paper (also attached).

Cheers,

Bill

William L. Ellsworth
Earthquake Science Center
U.S. Geological Survey, MS-977 Office 1-650-329-4784
345 Middlefield Road Fax 1-650-329-5143
Menlo Park, CA USA 94025 e-mail ellsworth@usgs.gov

From: Dorsey, Nancy [mailto:Dorsey.Nancy@epa.gov]
Sent: Friday, June 05, 2015 11:59 AM
To: ellsworth@usgs.gov
Cc: Dellinger, Philip
Subject: relocated Oklahoma events

Hi Bill,

I am looking forward to reading your and your coworkers Leading Edge publications. Will the relocated Oklahoma (or other state) data be available for download? I would love to have a copy of it!

Thanks,
Nancy

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, June 11, 2015 4:30 PM
To: Charles Lord; 'Kellie Duncan'
Cc: Patricia Downey; Jim Marlatt; 'Megan Crocker'
Subject: USGS relocated events
Attachments: USGS_relocated.pdf; USGS_relocated.zip; McNamara_et_al-2015-Geophysical_Research_Letters.pdf

These are the events from the article by McNamara et al in the Leading Edge and previously in the Geophysical Research Letters.

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, June 11, 2015 2:43 PM
To: Johnson, Ken-E; Dellinger, Philip
Subject: FW: Conclusions from other Leading Edge articles - continued

Key bullets from intro, I found the first one … not surprising

- 'Although interest among operators in the topic is high, we did not receive submissions from oil and gas operators to this special section.'
- 2 USGS papers: 'the hazard posed by induced earthquakes is dissimilar to natural earthquakes in that there is a shorter-term time dependence to the underlying forcing that does not fit comfortably into current assumptions, methods, and timelines for hazard estimation.

Efforts to monitor and characterize the recent increasing seismicity in central Oklahoma

McNamara et al; USGS+

Conclusions

Traditionally, it has been difficult to develop spatial correlations between earthquakes and specific faults in the central United States. This has resulted primarily from low seismicity rates and few well-constrained earthquake locations and moment-tensor solutions. The combination of the recent increased earthquake rate and good seismic-station coverage over a broad region of central Oklahoma allowed us to build a catalog of calibrated earthquake hypocenters and regional moment-tensor solutions. Combining RMT results with relocated seismicity enabled us to determine the length, depth, and style of faulting occurring on reactivated subsurface fault systems.

Using the catalog of earthquake-source parameters determined in this study, we delineate numerous reactivated subsurface faults throughout central Oklahoma and are working to provide guidance on which faults pose the highest hazard. The majority of the reactivated faults in the region is oriented favorably for earthquake rupture relative to the regional compressive- stress field. Earthquakes are shallow and are constrained primarily to the upper portion of the crystalline basement (a depth of less than 6 km), with some seismicity reaching into the overlying sedimentary bedrock. Many of the earthquakes relocated in this study coalesce from diffuse and scattered locations into discontinuous sequences with fault lengths of 1 to 12 km. Most of these discontinuous sequences are aligned consistently with the general fabric of the Nemaha and Wilzetta fault zones, but we are uncertain whether there are longer fault structures that tie these independent clusters together. Many earthquake sequences are associated directly with well-known structures of the Nemaha and Wilzetta fault zones. However, most earthquakes occur in the broad region of uplift and are not associated with known fault zones.

Recently, the Oklahoma Geological Society and the Oklahoma Corporation Commission have been collaborating on building an enhanced fault database for Oklahoma. This type of product will be valuable for understanding the faulting process and will help with mitigation efforts. Access to proprietary well and reflection data also could aid in understanding the relationship between recent seismicity and reactivated fault zones. In addition, new OCC regulations for reporting and monitoring of wastewater disposal wells will help to improve our understanding of the earthquake process. These are necessary first-order observations required to assess the potential hazards of individual faults in Oklahoma. Results from this study are important parameters required to assess both short-term (traffic-light) and long-term (NSHM) earthquake hazard. We suggest that the increased rate and occurrence of earthquakes near optimally oriented and long fault structures has raised the earthquake hazard in central Oklahoma and has increased the probability for a damaging earthquake.

A comparison of seismicity rates and fluid-injection operations in Oklahoma and California: Implications for crustal stresses

Thomas Göbel, California Institute of Technology.

Conclusion

My results suggest that operational parameters of surficial fluid injection are likely of secondary importance for the resulting seismogenic response. The primary controls on injection induced seismicity are the specific geologic setting, e.g., hydraulic connectivity, and the stress state on nearby faults. The view that injection-induced earthquakes have been avoided successfully in California in the past because of less invasive injection operations is likely erroneous. The scarcity of induced seismicity in California might simply be an expression of lower stresses at injection depth and lack of large-scale hydraulic connectivity within hydrocarbon basins. Although less probable, earthquakes might be induced in

California through injection in areas of active faulting, as shown by a recent study. The largely similar injection operations in California and Oklahoma and the absence of noticeable seismogenic response in California indicate a fundamental difference in the state of stress between the two study areas. The specific geologic conditions responsible for individual induced-earthquake sequences remain to be understood.

Induced seismicity of the Groningen gas field: History and recent developments

K. van Thienen-Visser1 and J. N. Breunese1, 1TNO – Geological Survey of the Netherlands.

Conclusions

The relationship among geologic, flow-dynamics, geomechanical, and seismological models has been studied for the Groningen reservoir. In this near-coastal region, surface subsidence is monitored, and predictions are used for pumping and dyke heights. Surface subsidence is caused by compaction, which is caused by production of gas. Observed mismatches between modeled and measured subsidence were explained by porosity anomalies and aquifer activity, illustrating the need for highquality static and dynamic models.

The induced seismicity of the Groningen reservoir is related to compaction, which results in stress changes on the many existing faults in the reservoir. The slip on those faults created the observed seismic events. Even though magnitudes are not as high as in tectonically active areas, intensities are quite high because of the relatively shallow depth and soft soils in the area, leading to damage of houses and infrastructure. The induced seismicity of the Groningen field increased in magnitude and number of events from 2003 to 2014, with the largest events occurring in areas where compaction is largest.

In 2014, production was reduced in the entire field, mainly focused on wells in the center of the field. Seismicity recorded in 2014 suggests that activity has decreased in the center of the field, correlating with the area where production was decreased. This would indicate a direct relation among production, compaction, and seismicity. It is, however, too early to convincingly provide statistical evidence to this statement.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, June 04, 2015 3:23 PM
To: Charles Lord; 'Matt Skinner'; Tim Baker; Patricia Downey
Cc: Jim Phelps; 'Megan Crocker'
Subject: about that California comparison

I recommend getting a copy of this month's Leading Edge (SEG publication). It is dedicated to induced seismicity. One of the articles was quoted in the bit Tulsa News spread, which I assume you have already seen.

A century of oil-field operations and earthquakes in the greater Los Angeles Basin, southern California

1. Egill Hauksson[1],
2. Thomas Göbel[1],
3. Jean-Paul Ampuero[1] and
4. Elizabeth Cochran[2]

+ Author Affiliations

1. [1]*California Institute of Technology.*
2. [2]*U. S. Geological Survey.*

1. Corresponding author: hauksson@caltech.edu

Abstract

Most of the seismicity in the Los Angeles Basin (LA Basin) occurs at depth below the sediments and is caused by transpressional tectonics related to the big bend in the San Andreas fault. However, some of the seismicity could be associated with fluid extraction or injection in oil fields that have been in production for almost a century and cover ~ 17% of the basin. In a recent study, first the influence of industry operations was evaluated by analyzing seismicity characteristics, including normalized seismicity rates, focal depths, and *b*-values, but no significant difference was found in seismicity characteristics inside and outside the oil fields. In addition, to identify possible temporal correlations, the seismicity and available monthly fluid extraction and injection volumes since 1977 were analyzed. Second, the production and deformation history of the Wilmington oil field were used to evaluate whether other oil fields are likely to experience similar surface deformation in the future. Third, the maximum earthquake magnitudes of events within the perimeters of the oil fields were analyzed to see whether they correlate with total net injected volumes, as suggested by previous studies. Similarly, maximum magnitudes were examined to see whether they exhibit an increase with net extraction volume. Overall, no obvious previously unidentified induced earthquakes were found, and the management of balanced production and injection of fluids appears to reduce the risk of induced-earthquake activity in the oil fields.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, June 04, 2015 3:15 PM
To: Dellinger, Philip; Bierschenk, Arnold; Johnson, Ken-E; Hildebrandt, Kurt; Bates, William
Cc: Lawrence, Rob; Overbay, Michael
Subject: FW: Leading Edge

Check out the abstracts for this issue…a MUST have!

From: Dorsey, Nancy
Sent: Thursday, June 04, 2015 3:12 PM
To: Morris, Abigail
Subject: Leading Edge

Would it be possible to get a copy of the June issue of the Leading Edge, please?

http://www.geoscienceworld.org/search?submit=yes&author1=&author2=&title=&andorexacttitle=and&titleabstract=seismicity&andorexacttitleabs=and&fulltext=&andorexactfulltext=and&fmonth=Jun&fyear=2014&tmonth=Jun&tyear=2015&pubdate_year=&volume=&issue=&firstpage=&doi=&domain=highwire&format=standard&hits=10&sortspec=relevance&group-code=gsw&resourcetype=HWCIT&submit=yes&submit=Submit

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

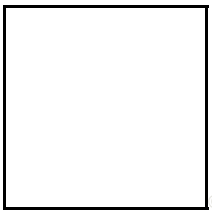
Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, May 07, 2015 12:04 PM
To: 'Matt Skinner'; Tim Baker; Charles Lord; Patricia Downey
Subject: FW: Shalequakes

Fracking: The energy revolution that shook the world

Barney Jopson

Scientists say shale boom to blame for Oklahoma's earthquakes, prompting calls for industry crackdown



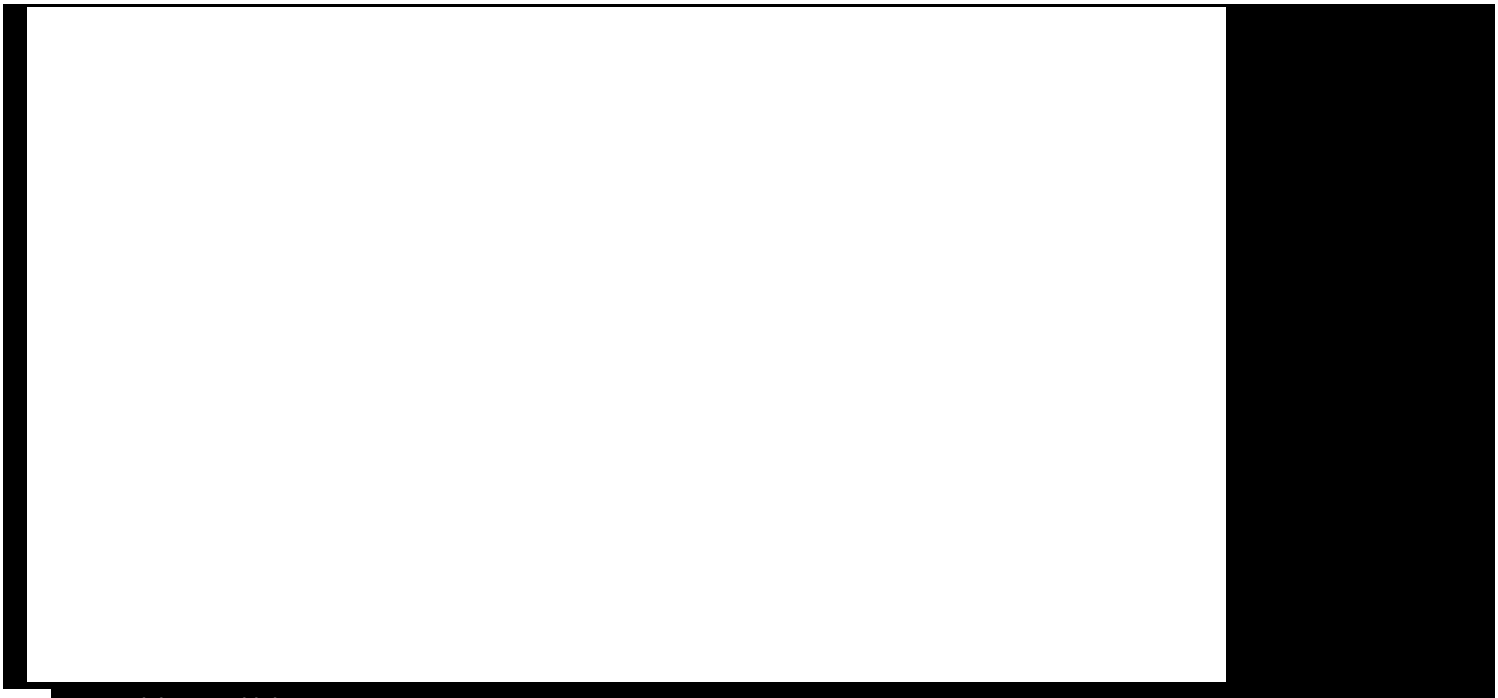
T

o hunting, shooting and fishing, a rugged Oklahoman named Mark Crismon has added one more hobby: seismography. Festooned on the walls of his backyard shed are antlers and bushy tails that once belonged to deer he has killed over the years. But these days his mind is on earthquakes.

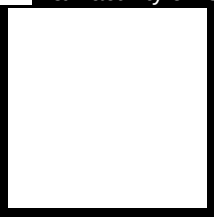
Mr Crismon's wares are arranged around a laptop connected to a seismometer from a local university, which is buried 3ft under his garden. It carries a nonstop feed of wavy lines recording the amplitude of ground vibrations across the state. At least once an hour, a sudden burst of spikes signals a tremor that someone will have felt — each one representing an unexpected new threat to the US's oil and gas revolution.

More video

The energy market has been transformed by surging production of "tight" oil and gas, which horizontal drilling and hydraulic fracturing (or fracking) are freeing from shale and other rock formations. With US oil output close to 10m barrels a day — the all-time high it hit in 1970 — America has cut its dependence on Middle Eastern imports, created thousands of jobs and produced an oil glut that has helped to lower the global crude price.



E&P activity on Oklahoma



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But Mr Crismon — and scientists who have studied the issue — say it is not all good news. They blame the shale boom for triggering a spate of earthquakes that are shredding nerves and damaging homes.

“It just tears everything. I got cracks everywhere,” says Mr Crismon, who compares the state to a war zone. “Instead of having bombs you got earthquakes.”

Quakes were rare in Oklahoma until 2009. But last year the state had a record 584 with a magnitude of 3.0 or over — more than in the previous 30 years combined, according to the Oklahoma Geological Survey. This has pushed the state past California to become the most rattled part of the continental US. No-one has been killed, but the largest recent quake, a magnitude 5.6 jolt in the tiny town of Prague in 2011, injured two people and destroyed 14 homes.

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- US fracking rules seek shale boom balance
- Pickens says US must cut oil output
- Fracking In the path of the ‘shale gale’
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- Shale groups rise to oil price challenge
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- Indonesia – No more Mr nice guy
- Volkswagen Gear change

The shale boom has been helped by a drill-first-ask-questions-later approach permitted by some US states. But the quakes could mark a turning point. Bob Jackman, a petroleum geologist and former oil and gas operator, says they are a “warning flag” that carelessness will catch up with oil companies. “It’s a caution to the fossil fuel industry that you must weigh other considerations.”

The industry — and many of its allies in government — are pushing back, questioning the reasoning of the seismologists who say fracking-related activity is to blame for the quakes.

Ban fears

But with each new tremor, public support for the industry crumbles a little more. And for companies already struggling to stay profitable in an era of cheap oil, two potentially costly risks are growing: the threat of compensation claims and the prospect of a ban on the practices blamed for earthquakes. “It would bring the industry to a halt, not in a matter of months or weeks or even days, but in a matter of hours,” says Kim Hatfield, president of Crawley Petroleum and the regulatory chief at the Oklahoma Independent Petroleum Association.

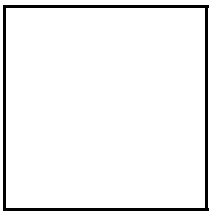
For other countries debating how to develop shale energy, including the UK and Germany, Oklahoma offers a salutary lesson. Despite a common misconception, the quakes are not triggered by fracking itself, which involves shattering rocks deep underground with a high-pressure cocktail of water, sand and chemicals. Instead, they result from what bursts out of the rock alongside oil and gas: vast amounts of ancient seawater. The water is worthless, so the industry injects it back underground via disposal wells. The problem is that the liquid has unlocked previously stable faults, creating the slippage that triggers a “shalequake”. Such tremors have also been felt in Texas, Colorado, Arkansas, Ohio and Kansas.

“There’s no longer any question that the majority of these excess earthquakes are being caused by the disposal of wastewater,” says Bill Ellsworth, a research geophysicist at the US Geological Survey.

Oil accounts for a bigger portion of Oklahoma’s economy than it does of Texas’s. According to an industry-backed study, it supports one out of every five jobs in the state. Liquid-based fracking was even invented in the state, in the late 1940s, when engineers tried to crack rocks by pumping down napalm left over from the second world war, according to Russell Gold’s book *The Boom*.

Oklahoma is a deep red Republican state and has been an industry bastion for decades. That has translated into significant political influence in Oklahoma’s state capitol. When Johnson Bridgwater of the Sierra Club, an environmental group, lobbied lawmakers recently on an energy issue, he was told they had been visited by 20 paid advocates — and that he was the only one not speaking for the oil industry. Mary Fallin, the Republican governor, and most state lawmakers have said as little as possible about earthquakes. Ms Fallin did not acknowledge the scientific consensus that wastewater injection triggers seismic activity until last month.

But on voters’ smartphones, apps that warn about Oklahoma’s tornadoes — commonplace in the state — have long since been crowded out by the trill of notifications about tremors.



Sceptical industry

The industry's reaction has echoes of its sceptical approach to climate change. "If you're certain, then how do we explain the fact that for 60 years we did wastewater injection and did not witness this seismicity?" asks Mr Hatfield of Crawley Petroleum. Today, he says, some areas that are experiencing earthquakes have no disposal wells, and some areas with disposal wells have no earthquakes. "It's not as simple as saying, OK, they're putting water in this well and that's causing that earthquake."

T Boone Pickens, the Oklahoma-born oil legend, is more succinct. "Earthquakes my ass," he told the FT.

The stakes for the industry are high, because wastewater disposal is a critical component of the shale business model. Disposing of a single barrel of water costs at least 25 cents and as much as $1, say industry executives. An operator with 100 wells each producing 1,000 b/d of water could spend as much as $100,000 on disposals. That can make up 50-60 per cent of operating costs when wells are new, though the figure declines to about 10 per cent as water output subsides, says Mr Hatfield.

The industry's difficulty is that there are no viable alternatives: trucking wastewater to wells far from faultlines would be prohibitively expensive. Anxious local residents are demanding an immediate moratorium on wastewater injection. But Chad Warmington, executive director of the Oklahoma Oil and Gas Association, a trade group for the biggest companies, says: "We need to be able to keep doing it, because without injection wells you don't have production. And without oil and gas production in the state of Oklahoma, the economic consequences are devastating."

The industry's other worry is that if a link is established between a particular well and a particular earthquake, it could open the door to a flood of lawsuits from people claiming damages. New Dominion, an Oklahoma-based producer, is being sued by a woman injured in the 2011 Prague quake, and its lawyer, Robert Gum, said in a hearing last year that if the suit were allowed to proceed: "These wells will become economic and legal liability pariahs."

Brian Bingman, president of the Oklahoma state Senate, is on the industry's side. He also works for it, at Upland Resources, when he is not a part-time lawmaker. He says it is important not to "overreact" to "pretty low-impact earthquakes". Oklahoma suffers when the industry is weak, he says, noting that a drop in oil and gas tax revenue due to the low crude price has left the state facing a $611m budget shortfall this year.

Disposal debate

A handful of lawmakers are sounding the alarm on quakes, among them Jason Murphey, a member of the state House of Representatives. He says he is free to acknowledge the causal role of wastewater disposal because he decided not to take campaign contributions from any group that lobbies politicians. For other legislators, he says, "it's very easy to make the choice to not talk about it, because there's really not an upside".

The issue has overwhelmed the state's oil and gas regulator, the Oklahoma Corporation Commission. But it has taken incremental steps. In May 2014, it introduced a seismicity review for all proposed disposal wells and said it would not allow any within three miles of a stressed fault. In March it asked the operators of existing wells in dangerous areas to prove they were not doing anything risky. When some of them could not, it ordered that the depth of 52 wells be reduced and that about 150 slash their disposal volumes by 50 per cent.

Dana Murphy, an OCC commissioner, says she is harangued by the industry for being too aggressive — and by residents for being too timid.

The governor has been Awol from the beginning and she has the power to do more

- Angela Spotts, co-founder, Stop Fracking Payne County

Tweet this quote

Angela Spotts, co-founder of a group called Stop Fracking Payne County, is one of those who wants more forceful action. It would probably require changes to the law. “The wells need to be shut down immediately,” she says.

Ohio and Arkansas have already made some areas off-limits for wastewater injection. Looking to Ms Fallin, she says: “The governor has been Awol from the beginning and she has the power to do more.”

New technology could provide a way out. At a research centre in Oklahoma City, GE, the industrial group, is looking for solutions to the wastewater problem. That could mean fracking in a way that avoids releasing so much water; finding ways to let it evaporate cleanly into the atmosphere; or purifying and then discharging it into lakes or rivers. But if the techniques are no cheaper than trucking the water cross-country, they might not make a difference.

It is likely to prove impossible to make some wells both safe and economically viable. If oil production is curtailed on a large scale as a result, it will put upward pressure on crude prices.

Puffing on a cigarette, Mr Crismon, the shed seismographer, says he would not mind paying more to fuel his car. “Let’s go back to Saudi Arabian oil. That would be fine with me, rather than putting up with earthquakes. I’m not worried about my gas bill. I’m worried about hundreds of thousands of dollars of damage to my house.”

Geology — Disposal of wastewater, not fracking, blamed for ‘shalequakes’

In industry parlance, the oil operations at the root of Oklahoma’s earthquake crisis are called “dewatering plays” — and with good reason. For each barrel of crude produced by an average Oklahoma well, 10 barrels of saltwater gush out of the shattered rock. No one wants to drink or shower in this briny byproduct, which is tainted by toxic chemicals. So it has to be discarded.

Many years ago it would have been dumped into rivers and creeks, wreaking ecological havoc. But the industry came up with an alternative: it started injecting the water back underground at separate sites called disposal wells, where it is absorbed by sponge-like rocks.

Oklahoma is pocked by 11,000 such wells. But it turns out that they are not the tidy solution they first seemed. When the wells are near faultlines — which are scattered across the map of Oklahoma — they can cause problems. By increasing fluid pressures underground, the water upsets the forces that had kept opposing bits of the earth’s crust clamped together. Faults that had been stable are unlocked and the resulting slippage of rock triggers a “shalequake”.

Pointing the finger of blame at the industry, the Oklahoma Geological Survey says the surge in quakes is “very unlikely” to be the result of natural forces.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, April 27, 2015 1:45 PM
To: Charles Lord; Tim Baker; Patricia Downey; 'Matt Skinner'
Subject: FW: New, news, and more news.

http://www.eenews.net/stories/1060017481

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, April 24, 2015 10:52 AM
To: Charles Lord
Subject: ouch!

Daily Show: http://www.washingtonpost.com/blogs/the-fix/wp/2015/04/24/jon-stewart-on-why-oklahoma-wont-stop-fracking-even-though-earthquakes-are-increasing/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, April 07, 2015 3:47 PM
To: 'Matt Skinner'; Tim Baker; Charles Lord; Patricia Downey
Subject: NPR broadcast tomorrow: Galchen; Keranen; Ferate; Spotts

http://onpoint.wbur.org/2015/04/08/fracking-natural-gas-oklahoma-earthquakes

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, April 02, 2015 12:37 PM
To: Charles Lord
Subject: Scientific Principles Affecting Protocols for Site-characterization and Risk Assessment Related to the Potential for Seismicity Triggered by Saltwater Disposal and Hydraulic Fracturing

Zoback and friends just published an 80 page report on scientific principles with Class IID induced seismicity (my words not theirs).

https://pangea.stanford.edu/researchgroups/scits/publications

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, March 31, 2015 8:19 AM
To: R6 6WQ-SG; Bates, William; Hildebrandt, Kurt; Lawrence, Rob
Cc: Tim Baker; Charles Lord; Matt Skinner; Patricia Downey
Subject: very good interview on induced seismicity by Austin Holland

http://www.oilandgasinvestor.com/videos/examining-earthquakes-oilpatch-786116

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Graves, Brian
Sent: Monday, March 30, 2015 2:22 PM
To: R6 6WQ-SG; Brown, Jamesr; Bates, William; Hildebrandt, Kurt; Kobelski, Bruce; Lawrence, Rob
Subject: Oklahoma Expands Disposal Well Scrutiny Amid Ongoing Concerns on Seismic Activity

Oklahoma Expands Disposal Well Scrutiny Amid Ongoing Concerns on Seismic Activity

By Paul Stinson BNA

March 27 — Under new directives issued by Oklahoma's energy and gas regulator, disposal wells operating in “areas of interest” that inject wastewater into the state's deepest geologic formation will have until April 18 to prove the injections do not go below the Arbuckle formation.

Presented as part of a March 25 town hall meeting in Medford, Okla., officials with the Oklahoma Corporation Commission laid out the details of their latest efforts, while residents received a seismicity update from the Oklahoma Geological Survey (OGS).

Hailed by the OCC as part of the agency's evolving campaign to address increased seismic activity levels via its “traffic light” system of best practices, the commission on March 18 sent letters to 92 companies holding permits to operate wastewater disposal wells in those areas, asking them to prove to the OCC Oil and Gas Conservation Division that their disposal wells aren't releasing wastewater below the Arbuckle formation.

In early February, the OCC “traffic light” system resulted in the state-ordered shut-in of an Alfalfa County disposal well in Northern Oklahoma operated by SandRidge Energy Inc. following a 4.1 magnitude earthquake .

The letter from the commission directs companies to provide evidence that their wells are not at a depth most likely to trigger earthquakes, which “are not disposing into or in communication with the crystalline basement rock.”

Potential to Cause Earthquakes

“There is broad agreement among seismologists that disposal below the Arbuckle poses a potential risk of causing earthquakes, as it puts the well in communication with the solid ‘basement' rock,” according to a March 26 release issued by the OCC.

“The Oklahoma Corporation Commission today took appropriate and necessary action to ensure there are no disposal wells below a certain depth in an area we believe is vulnerable to seismic activity,” Oklahoma Gov. Mary Fallin (R) said in a March 25 statement issued in conjunction with the town hall.

Operators who don't show that the well is not disposing wastewater below the Arbuckle and who do not have an approved plugging plan will be required to reduce their disposal volume by 50 percent, the commission said.

The directive applies to 347 of the approximately 900 Arbuckle disposal wells in Oklahoma.

A record number of tremors in the state raises the possibility of damaging earthquakes for central and north-central Oklahoma, according to the presentation delivered at the Medford town hall by the Oklahoma Geological Survey.

Oklahoma experienced 585 earthquakes of 3.0 magnitude or higher in 2014, eclipsing the cumulative amount of activity in the past 35 years.

“The observed rates of seismicity are very unlikely to represent a naturally occurring rate change,” the OGS noted in its presentation.

Concerns over OCC Funding

Responding to the OCC actions, Oklahoma Sierra Club Director Johnson Bridgwater said the organization “is encouraged by the new development,” but he questioned whether there are enough resources being dedicated to address state seismicity.

“[B]y their own admission, the OCC does not have the funding needed to do all they can to address the issue of induced seismicity caused by injection wells,” Bridgwater told Bloomberg BNA in a March 27 e-mail. “So we have concerns over how this additional work will actually be paid for and completed.”

Fallin also announced that $50,000 would be transferred by Secretary of Energy and Environment Michael Teague to the commission “to assist in the hiring of additional staff” to track injection wells in the state.

“The OCC faces yet another budget cut for 2015 as the State of Oklahoma faces a $600 million shortfall, so we hope plans are being made to help them beyond the $50,000 offered by the Governor via the Secretary of Energy and Environment,” Bridgwater said. “Our big concern is that they have the funding needed to aggressively address the issue.”

Area of Well Scrutiny Doubles

According to the commission, part of the OCC effort to address seismicity concerns will now include “evolving” the definition of “area of interest” to include “seismic swarms.”

A swarm is defined as an area consisting of at least two events with epicenters within 0.25 miles of one another, with at least one event with a magnitude 3.0 or higher. An area of interest is a 10-kilometer area (6.2 miles) with the central mass of the swarm serving as the area center.

As previously defined, area of interest designations amounted to a 10-kilometer area circle around a 4.0 magnitude earthquake.

“The change will more than double the number of disposal wells within an area of interest,” according to the commission.

For More Information

The Oklahoma Corporation Commission letter is available at http://op.bna.com/env.nsf/r?Open=smiy-9uztcz.

The Oklahoma Geological Survey presentation is available at http://op.bna.com/env.nsf/r?Open=smiy-9uztfk.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, March 26, 2015 9:35 AM
To: R6 6WQ-SG; Bates, William; Hildebrandt, Kurt
Cc: Brown, Jamesr
Subject: Medford Townhall write-up

http://www.tulsaworld.com/earthquakes/state-adds-new-earthquake-zones-requirements-for-well-operators/article_1a70dbde-0cc0-5d7a-8874-dd8061d23555.html

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, March 26, 2015 9:28 AM
To: R6 6WQ-SG; Bates, William; Hildebrandt, Kurt
Subject: from OGS website
Attachments: Holland_etal_2014_AGUpres_Multidisc Approach to ID and Mitigate IS in OK.pdf

Gee, where have I heard that mantra, Multidisciplinary Approach, before?

http://wichita.ogs.ou.edu/documents/2014/OF1-2015.pdf For those really into seismological analysis, this links to the OGS summary report of earthquakes for 2014.

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, March 26, 2015 8:53 AM
To: Johnson, Ken-E; Graves, Brian; Bierschenk, Arnold; Lawrence, Rob
Cc: Brown, Jamesr
Subject: FW: From EnergyWire -- EARTHQUAKES: Okla. officials expand scrutiny of disposal in quake-prone zones

From: bates.william@epa.gov by E&E Publishing [mailto:email_this@eenews.net]
Sent: Thursday, March 26, 2015 8:21 AM
To: Kobelski, Bruce; Green, Holly; Dorsey, Nancy; Dellinger, Philip
Subject: From EnergyWire -- EARTHQUAKES: Okla. officials expand scrutiny of disposal in quake-prone zones

This EnergyWire story was sent to you by: bates.william@epa.gov

ENERGYWIRE

AN E&E PUBLISHING SERVICE

EARTHQUAKES:
Okla. officials expand scrutiny of disposal in quake-prone zones

Mike Soraghan, E&E reporter

Published: Thursday, March 26, 2015

OKLAHOMA CITY -- State oil and gas officials here are doubling the number of disposal wells under scrutiny for signs they could be causing earthquakes.

As part of that scrutiny, officials at the Oklahoma Corporation Commission (OCC) also could order about nine wells, and possibly many more, to shut down and be temporarily reworked because they permitted companies to drill too deep.

About 380 wells already must record daily the volume of drilling waste they inject deep underground and the pressure they use. They are in "areas of interest" because they're within 6 miles of where a magnitude-4 earthquake has occurred.

But yesterday, OCC made public its plan to expand areas of interest to include wells within 6 miles of an earthquake swarm. The agency defines a swarm as two earthquakes within a quarter-mile of each other, if one of the quakes is magnitude 3 or greater. That will put another 350 wells that inject into the Arbuckle formation under that extra scrutiny.

Officials say they're concentrating at first on the Arbuckle formation. Hundreds more wells could come under scrutiny when they move on to other formations.

The companies that own those wells will also have to demonstrate to the agency that they are not injecting in, or too close to, the granite bedrock zone known as the "basement."

"There is general agreement among seismologists that fluid disposal into or in communication with the crystalline basement rock presents a potential risk for induced seismicity," Tim Baker, director of the OCC's Oil and Gas Conservation Division, wrote in a letter sent to companies that own the affected wells.

Under that **directive**, at least nine wells could be required to close temporarily to be "plugged back" -- changed to inject at a shallower depth. Even though they have valid permits allowing them to inject just above the basement layer, officials fear that the fluid they inject could affect basement rock.

The nine wells are those that are known to be injecting into zones near the basement. Closer examination could reveal many more injecting into the basement or too close.

The changes stop far short of the moratorium on high-volume disposal wells that some drilling critics have demanded. They also do not require operators to reduce volumes or pressures, so long as they comply.

Gov. Mary Fallin (R) yesterday signaled her support for the measures being undertaken by the commission.

"The Oklahoma Corporation Commission today took appropriate and necessary action to ensure there are no disposal wells below a certain depth in an area we believe is vulnerable to seismic activity," Fallin said in a statement.

Dealing with the 'swarms'

The changes are the latest in a series of incremental moves the OCC has taken in response to growing swarms of earthquakes in the state. The agency calls its approach the "traffic light" system.

In 2014, Oklahoma had 585 earthquakes of magnitude 3 or greater, three times more than California.

The U.S. Geological Survey and many academic researchers say the surge in earthquakes is linked to disposal of oil and gas waste fluid. The Oklahoma Geological Survey (OGS) has been equivocal, acknowledging that disposal can cause quakes but sharply rejecting most specific correlations by outside scientists.

When OGS did cautiously join with outside scientists in a 2013 statement linking quakes and disposal, the state seismologist was called into a meeting with University of Oklahoma President David Boren and Continental Resources Inc. founder Harold Hamm (***EnergyWire***, March 3).

Hamm, a major donor to the school, rejects the idea that the quakes are linked to oil and gas activity.

But in a forum last week, the state seismologist, Austin Holland, linked many of the state's quakes to oil and gas activity.

"It appears quite likely most of the seismicity we're seeing in northern and north-central Oklahoma is most likely due to this wastewater disposal," Holland said. "It's hard to explain this as a natural variation."

State officials say the basics of their "traffic light" system of dealing with disposal wells came together in May 2014. In Oklahoma, eight disposal wells have received the conditional "yellow light" permits. Some wells, proposed for "red light" areas, haven't been permitted at all (***EnergyWire***, March 9).

Companies under the extra scrutiny could appeal the staff's actions and get a hearing before an administrative law judge. So far, though, none has.

Traffic lights signal disposal wells' link

The OCC has continued permitting high-volume wells, and the seismic activity has intensified. Last year, there was an average of 1.6 quakes a day of magnitude 3 or greater. This year, the rate has been 2.26 a day.

Older wells have continued to operate, even though they've been linked by seismologists to a quake sequence called the "Jones Swarm" and the state's largest recorded earthquake, a magnitude-5.7 rupture in November 2011.

The traffic light approach is a tacit acknowledgment that disposal wells could be linked to man-made earthquakes. But officially the agency says it has no position on the cause and doesn't need to take one.

"While a direct, definitive link of oil and gas activity to the current major seismic events in Oklahoma has not been be established," states a posting on the agency website, "the Oklahoma Corporation Commission is not waiting for one."

The traffic light approach traces back to a National Academy of Sciences report in 2012. Illinois adopted a similar system when it wrote a state law governing shale gas drilling in 2013.

environmental and political issues surrounding the rapidly expanding unconventional energy industry and the numerous factors -- from expanding natural gas use to renewables and more -- that are altering the traditional electric utility industry. EnergyWire publishes daily at 9:00 a.m.

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Phone: 202-628-6500 Fax: 202-737-5299
www.eenews.net

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, March 26, 2015 8:28 AM
To: Lawrence, Rob; Johnson, Ken-E; Graves, Brian; Bierschenk, Arnold
Cc: Brown, Jamesr; Garcia, David
Subject: FW: From EnergyWire -- EARTHQUAKES: In Okla. quake country, still doubt about links to drilling

I will work on getting a copy of the new regs!

From: bates.william@epa.gov by E&E Publishing [mailto:email_this@eenews.net]
Sent: Thursday, March 26, 2015 8:19 AM
To: Kobelski, Bruce; Green, Holly; Dorsey, Nancy; Dellinger, Philip
Subject: From EnergyWire -- EARTHQUAKES: In Okla. quake country, still doubt about links to drilling

This EnergyWire story was sent to you by: bates.william@epa.gov

ENERGYWIRE

AN E&E PUBLISHING SERVICE

EARTHQUAKES:
In Okla. quake country, still doubt about links to drilling

Mike Soraghan, E&E reporter

Published: Thursday, March 26, 2015

MEDFORD, Okla. -- R.J. Parrish came to a town hall meeting about earthquakes here last night skeptical about the connection between the shaking and the oil and gas industry.

He left just as doubtful.

"I'm not fully convinced it's not just nature," said Parrish, a farmer from nearby Hunter, as people ambled out of the hall. "I don't want to stop the industry from doing anything."

Parrish has had some damage to his home from earthquakes. But the new house he built in part with money from royalties for the oil and gas under his farm seems more stable.

Federal and academic scientists say that the unprecedented shaking in Oklahoma is linked to oil and gas activity, specifically deep underground disposal of drilling wastewater. The state had 585 quakes last year, three times as many as California.

But Parrish is joined in his skepticism by the state's leaders, including Gov. Mary Fallin (R), who told *The Tulsa World* earlier this year that "a lot of it's just natural earthquakes that have occurred since

the beginning of the Earth," while acknowledging concerns about injection wells (***EnergyWire***, March 3).

State Insurance Commissioner John Doak has warned insurance companies against denying claims based on the "unsupported belief" that Oklahoma quakes are man-made. And the state's richest oilman, Continental Resources Inc. founder Harold Hamm, has said of quake activity, "It's certainly not related to oil and gas activity."

The state scientists those leaders turn to for answers have been equivocal. The Oklahoma Geological Survey has rejected findings by other scientists tying specific earthquakes to specific oil and gas activity. But at a forum last week, state seismologist Austin Holland said the quakes in northern Oklahoma are "most likely due to this wastewater disposal."

He didn't go quite that far last night, though he didn't argue that the quakes were natural.

"The areas seeing the most earthquake activity are the areas with the highest density of disposal wells," Holland told the crowd in Medford. "We know that something's changed."

The Oklahoma Corporation Commission (OCC), which regulates oil and gas in the state, says it has no position on whether drilling activity causes the quakes.

"We don't get into causality," commission spokesman Matt Skinner said last night. Still, the agency is placing restrictions on some wells in response to quakes.

To A.J. Ledwig, a retired school superintendent who lives in Medford, it's clear that oil and gas activity is causing the quakes. He sees the parsing of words as an excuse for inaction.

"I think the studies are going to go on and on," he said after the meeting. "I'm in my mid-70s, and my house is cracking up. What am I going to do?"

Shaken, and shaken again

The town hall meeting was held here last night because Medford is the seat of Grant County. With at least 177 quakes last year, Grant is possibly the most earthquake-prone county in the most earthquake-prone state in the Lower 48 (***EnergyWire***, Feb 9).

Medford and Grant counties are in the middle of the Mississippi Lime, an oil play where wells produce as much as 10 barrels of wastewater for every barrel of oil.

Wastewater injection surged in Grant and neighboring Alfalfa County in 2013, and earthquakes surged in 2014.

So, last night, about 150 people sat on metal folding chairs on the concrete floor of the Civic Center in Medford, a farm town astride railroad tracks closer to the Kansas border than it is to Oklahoma City. Holland sat on a stage next to OCC staff, taking questions from residents who have been repeatedly shaken by earthquakes that have reached above magnitude 4.0.

"I've been in California earthquakes. They're not anything like this," said Bonnie Wills of Medford. She said her home on the other side of Oklahoma City was damaged in the November 2011 magnitude-5.6 quake that is the largest recorded in the state.

"We moved from there. We come up here, and it's even worse," she said.

Skinner, the public face of the regulatory agency, told the crowd his house in Guthrie has suffered damage from earthquakes, as have the homes of other OCC officials.

"I know how horrible it is for you," he said. "It's almost a dehumanizing experience."

But Parrish, the skeptic, brought a humorous approach to the meeting.

He and his wife Peggy wore matching shirts from a Stillwater bar that has nicknamed itself "The Earthquake Zone." The back of the shirt reads, in neon-green letters, "Did you feel that one?"

Mom and pop vs. Wal-Mart

Those who stepped to the microphone to ask questions were less amused. One questioner asked why oil companies aren't required to pay to fix earthquake damage. Skinner said regulators don't have the authority to do that.

"There's nothing there we have any jurisdiction over," Skinner said. "That's a question for the Legislature."

Bob Jackman, a Tulsa geologist who has been a frequent critic of the state's response to the quakes, noted that Arkansas and Ohio shut down wells that were linked to quakes. Skinner said those states have far fewer wells.

"That's like comparing a mom-and-pop store to Wal-Mart," Skinner said. "They have very few wells. It's much easier to shut them down."

He said the commission has had some success in stopping or limiting earthquakes by requiring operators to "plug back" wells that were injecting wastewater too deep.

"We have seen some operations plug back and then seen the seismicity decrease," Skinner said.

The commission is expected to order more plug backs under a new directive rolled out yesterday, expanding the number of wells under heightened scrutiny for seismic risk.

Fallin praised the new directive in a statement yesterday, saying it was important that wells not be drilled too deep, since OCC evaluations have shown that they "could potentially contribute to earthquakes."

ABOUT ENERGYWIRE – THE TRANSFORMATION OF THE ENERGY SECTOR

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Phone: 202-628-6500 Fax: 202-737-5299
www.eenews.net

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, March 23, 2015 11:52 AM
To: R6 6WQ-SG; Bates, William
Subject: Oklahoma Earthquake map by the press - at least the link

http://newsok.com/earthquakes

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, March 23, 2015 10:45 AM
To: Overbay, Michael; Dellinger, Philip; R6 6WQ-SG
Subject: RE: Town hall meeting in OKC last night on quakes

Maybe you have to be registered or something. The link worked fine for me.

From: Overbay, Michael
Sent: Monday, March 23, 2015 10:44 AM
To: Dellinger, Philip; R6 6WQ-SG
Subject: RE: Town hall meeting in OKC last night on quakes

The link did not work for me, but I found the story and here it is:

by Paul Monies Published: March 20, 2015
What to do about the rise in earthquakes in Oklahoma and the possible links to wastewater injection wells from oil and gas activity drew questions at a town hall forum in Oklahoma City.

Asked to signal by applause, the attendees at Oklahoma City University appeared split over whether they thought earthquakes were being caused by the energy industry. The Thursday town hall, sponsored by television station KOKH-25, featured representatives from science, industry, regulators and government officials.

Many of the questions, both in person and via social media, showed the level of interest in the issue for Oklahomans, who haven't typically had to deal with earthquake activity. The number of earthquakes has risen dramatically over the last five years.

Rep. Jason Murphey, R-Guthrie, said earthquakes are one of the top concerns of his constituents. He said the oil and gas industry is a valuable part of the economy and urged an "Oklahoma solution" to deal with the risks from earthquakes. Any solution has to be based on science, not knee-jerk reactions, he said. Still, Murphey said if a future, large earthquake caused significant damage, it would leave a "cloud" over future energy industry activity.

Some of the attendees asked why Oklahoma hasn't instituted a moratorium on wastewater injection wells in areas of recent earthquake activity. Matt Skinner, spokesman for the Oklahoma Corporation Commission, said Oklahoma's current laws don't allow that.

"That's not an excuse," Skinner said. "It just means we have to operate in a different legal environment."

The Corporation Commission has put in place a "yellow-light" permit program for disposal wells. Commission staff has broad discretion to ask operators to reduce pressure or volumes in areas of recent earthquake activity. Skinner said the commission has asked operators to shut down wells tied to earthquakes.

Murphey said there's not the political will at the Legislature to allow a moratorium. He said due process must be followed. Under current law, a moratorium could open up regulators to legal claims for not allowing mineral owners to use their property.

Other attendees asked about the possibility of a ban on hydraulic fracturing, or fracking. Austin Holland, a seismologist with the Oklahoma Geological Survey, reminded the audience of the difference between fracking and wastewater disposal wells.

Hydraulic fracturing is a technique used to stimulate wells by injecting water, sand and chemicals into small rock fissures to release more oil and natural gas. The disposal wells that are being looked at for possible links to earthquake activity are injecting water that is produced from energy development back into the ground.

The water issue drew several questions, with some pointing to the drought in Oklahoma and the need to conserve water. Tim Baker, with the Corporation Commission, said the energy industry uses about 2 percent of the water in Oklahoma. Most of the state's water is used for agriculture, golf courses and home and garden use. But one attendee said the water used by the energy industry doesn't go back into the water cycle like water used for other purposes.

Steve Everley, a representative from the industry group Energy in Depth, said many oil and gas operators are looking at recycling the water they use. But he said the ability to do that varies by location.

Holland said the industry has shared data on faults, which has allowed researchers to update the seismic map in Oklahoma. Additional seismic monitoring stations have also given a more complete picture of the state's complex geology, he said.

From: Dellinger, Philip
Sent: Friday, March 20, 2015 1:23 PM
To: R6 6WQ-SG
Subject: Town hall meeting in OKC last night on quakes

Check out questions and answers.

http://newsok.com/article/5402870?scrolling_list=article_small

Dorsey, Nancy

From: Matt Skinner <M.Skinner@occemail.com>
Sent: Monday, March 16, 2015 1:09 PM
To: Dorsey, Nancy
Subject: RE: seis in media
Attachments: 03-09-15Energywire-Amid the shaking, Okla. regulators take a case-by-cas....doc

Thanks. I speak to Mike pretty much on a daily basis.

In case you haven't seen the follow up (which he was working on when he did the TV shot), see attached>

From: Dorsey, Nancy [mailto:Dorsey.Nancy@epa.gov]
Sent: Monday, March 16, 2015 12:54 PM
To: Tim Baker; Charles Lord; Matt Skinner
Subject: FW: seis in media

In case you hadn't seen this.

From: Dellinger, Philip
Sent: Monday, March 16, 2015 12:06 PM
To: R6 6WQ-SG
Subject: seis in media

Did a search on Greenwire and found all kinds of recent things. Here is a video with Mike Soraghan. He has done many stories on the topic, including our work. He has taken great interest in the situation in Oklahoma.

http://www.eenews.net/tv/videos/1949/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, February 11, 2015 8:28 AM
To: Brown, Jamesr; Lawrence, Rob; Mayer, Rebecca
Cc: Johnson, Ken-E; Graves, Brian; Bierschenk, Arnold
Subject: Phil's actual GWPC presentation
Attachments: Seis for Austin GWPC 2-9-15.pptm

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, February 06, 2015 9:47 AM
To: Dellinger, Philip
Subject: SITE FOR REPORT

http://www.epa.gov/region5/water/uic/techdocs.htm

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, December 08, 2014 1:55 PM
To: Charles Lord
Subject: FW: New York Times article on Oklahoma

From: Bates, William
Sent: Monday, December 08, 2014 11:36 AM
To: Dorsey, Nancy
Subject: New York Times article on Oklahoma

Hi Nancy,

Not sure if you saw this, but I thought it was interesting. Enjoy. ☺

http://www.nytimes.com/2014/12/07/us/politics/energy-firms-in-secretive-alliance-with-attorneys-general.html

---

William J. L. Bates
Geologist
U.S. EPA
Office of Ground Water & Drinking Water: Prevention Branch
202-564-6165

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, December 08, 2014 9:22 AM
To: Charles Lord; Tim Baker; Dellinger, Philip
Cc: Johnson, Ken-E; Lawrence, Rob
Subject: Interesting Wilzetta related thesis from OGS website
Attachments: Toth_thesis2014 Separation of the Earthquake Tomography Inverse Problem to Refine Hypocenter Locations and Tomographic Models.pdf

Toth, thesis 2014: Separation of the Earthquake Tomography Inverse Problem to Refine Hypocenter Locations and Tomographic Models

Chapter 5: Conclusions

Whether the 2011 M5.7 Wilzetta Fault rupture sequence was natural or induced, misidentifying its cause carries significant ramifications. If this episode of seismicity were to be falsely determined to partially be a product of human activities, then one of the strongest recorded earthquakes to have occurred in intra--continental North America would be omitted from seismic hazard assessment by the USGS. Conversely, if the seismicity were incorrectly determined to be natural, then the largest induced earthquake would be omitted from our understanding of the risks of subsurface fluid injection. Extra diligence must therefore be paid when it comes to identifying the nature of this seismicity, which begins with generating accurate velocity models of the subsurface and locating hypocenters in these models.

...

Despite the earthquakes being located shallower in the 3D model than in the 1D model, we find that the seismicity is still generally occurring deeper than what has previously been reported Keranen et al. (2013). The lack of hypocenters in the sedimentary column, and the recent structural mapping by Dycus (2013) are inconsistent with the model proposed by Keranen et al. (2013) citing reservoir pressure within a fault--bounded block in the Arbuckle Group as triggering the WFZ aftershock sequence. However, since their analysis only focused on the first few days of seismicity, whereas ours focused on earthquakes large enough to be observed through our entire study area, the datasets, and therefore the results, may not be directly comparable.

Despite the success of this experimental dataset and processing approach, the experimental survey design used here should be modified before being used again in the future. Due to the potential for earthquakes to occur at a substantial distance from densely spaced receivers, 3D tomography is required to accurately process the resultant dataset, and therefore a broader, more grid--like distribution of receivers should be used in the future. Furthermore, since there will always be inherent uncertainty in earthquake locations, and that the checkerboard testing showed that the smallest resolvable feature was ~5km, the station--station spacing of 0.5km in areas was unnecessarily dense. While additional stations are useful in the source areas to constrain hypocenters, the highly clustered nature of the seismicity minimized the number of crossing rays, thereby minimizing the resolving power of the tomography. Therefore, a broader, grid--like distribution of receivers would have produced better results.

Dycus, M., 2013, Structural Characterization of the Wilzetta Fault Zone: Lincoln, Pottawatomie, and Creek Counties, Oklahoma [M.S. Thesis]: University of Tulsa.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, December 08, 2014 8:22 AM
To: Charles Lord; Tim Baker
Subject: Sure you have seen this - Payne Co EQ

Importance: High

http://www.koco.com/news/Earthquake-concerns-over-Payne-County-injection-wells/24809730

The lady interviewed is calling EPA. I have not talked with her yet.

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, December 03, 2014 11:18 AM
To: R6 6WQ-SG; Brown, Jamesr; Lawrence, Rob
Subject: earthquakes of note
Attachments: 2014-12-02 15:36:21 (M2.7) NORTHERN TEXAS 32.9 -96.9 (63093); 2014-12-03 13:33:33 (M4.0) OKLAHOMA 36.5 -99.0 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, December 02, 2014 10:14 AM
To: Dellinger, Philip
Subject: FW: 2014-12-01 17:57:28 (M3.9) OKLAHOMA 36.5 -99.1 (63093) -- getting up there! 3.9M

Importance: High

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Monday, December 01, 2014 2:33 PM
To: Dorsey, Nancy
Subject: 2014-12-01 17:57:28 (M3.9) OKLAHOMA 36.5 -99.1 (63093)

M3.9 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.9
Date-Time	1 Dec 2014 17:57:28 UTC 1 Dec 2014 11:57:29 near epicenter 1 Dec 2014 10:57:28 standard time in your timezone
Location	36.495N 99.079W
Depth	7 km
Distances	12 km (7 mi) ENE of Mooreland, Oklahoma 28 km (17 mi) ENE of Woodward, Oklahoma 108 km (66 mi) W of Enid, Oklahoma 112 km (69 mi) NNW of Weatherford, Oklahoma 181 km (112 mi) NW of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 6.2 km
Parameters	Nph = 0; Dmin = ; Rmss = 0.68 seconds; Gp = 196° Version =
Event ID	us b000t1x1

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey

http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, November 19, 2014 8:25 AM
To: Charles Lord; Tim Baker
Subject: FW: Mark C made Tulsa news.

I assume you have seen this.

From: Dellinger, Philip
Sent: Wednesday, November 19, 2014 7:17 AM
To: R6 6WQ-SG; Lawrence, Rob
Cc: Brown, Jamesr
Subject: Mark C made Tulsa news.

http://www.newson6.com/story/27422650/multiple-earthquakes-ruining-payne-county-mans-home

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, November 03, 2014 9:08 AM
To: Tim Baker; Charles Lord
Subject: FW: From EnergyWire -- EARTHQUAKES: Up to 10 percent of Okla. quake surge comes from fracking -- state scientist

Importance: High

ENERGYWIRE

AN E&E PUBLISHING SERVICE

EARTHQUAKES:
Up to 10 percent of Okla. quake surge comes from fracking -- state scientist

Mike Soraghan, E&E reporter

Published: Friday, October 31, 2014

Oklahoma's state seismologist said yesterday that "up to 10 percent" of the surge in earthquakes in his state could have been caused by hydraulic fracturing rather than wastewater disposal.

"It's more common than currently recognized," Austin Holland, seismologist at the Oklahoma Geological Survey, said at a forum on man-made earthquakes at the Washington offices of the U.S. Energy Association. "Up to 2 percent of completed wells may have earthquakes associated with that completion process."

But he said he believed the fracturing-related quakes are scattered "around the edges" of the state's earthquake zones and not responsible for any of the major "swarms" of seismicity in the state. Oklahoma has had more earthquakes than California this year, and scientists have linked most of them to disposal of drilling wastewater. The state had three earthquakes yesterday.

Within the debate about man-made earthquakes linked to oil and gas production, there is a sub-debate on whether fracking causes earthquakes of significant magnitude or in significant numbers.

U.S. Geological Survey scientists and many of their academic colleagues say the specific process of fracturing -- injecting fluid underground at high pressure -- does not cause earthquakes that present a hazard. It is earthquakes caused by disposal, they say, that really present a hazard. Fracking quakes are considered something of a distraction (***EnergyWire***, April 23, 2012).

But the scientist who oversees USGS's earthquake hazards program muddied that a little himself yesterday when he noted that fracking has been linked to a magnitude-4.2 quake in a remote area of Alberta. Magnitude 4.0 is roughly the level that seismologists expect to start seeing significant damage.

"These are very rare and present a challenge to understanding this," Bill Leith said. "Fracking is only rarely the cause of felt earthquakes."

Earthquakes have also been linked to the fracturing process in England, British Columbia and Ohio.

Leith said USGS avoids talking about hydraulic fracturing and earthquakes in Oklahoma because many of the quakes in the state have been linked to a production practice that involves no fracking. It's called "dewatering" and involves pumping water out of declining oil fields to free up remaining crude. Dewatering creates as much as 1,000 times more water than oil, and many wells have a ratio that's as much as 200 times higher than conventional wells (***EnergyWire***, July 14).

But Holland said hydraulic-fracturing-related earthquakes present a great research opportunity because drilling companies gather precise information on their fracturing work. They collect more data, and it's more precise than the data on their disposal of wastewater.

"We are looking at using potential cases of induced seismicity as sort of these virtual laboratories," he said. "Hydraulic fracturing, because it's easy to identify and has a lot more data, may be a great source for these virtual observatories."

Holland said he is working on a scientific paper detailing his findings on fracturing and earthquakes but keeps getting delayed by new earthquakes deserving of study.

Also yesterday, a top Exxon Mobil Corp. engineer said his company is doing risk analysis for earthquake potential for each of the handful of disposal wells it drills each year.

"We do this for every one of our wells now," said Kris Nygaard, Exxon's recognized expert on hydraulic fracturing and similar processes. Plans for two wells, he said, have been changed as a result.

Nygaard said Exxon realizes that earthquakes generate a lot of concern among the public.

"People are bothered when there's shaking going on," he said, "and they want it to stop."

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numerous factors -- from expanding natural gas use to renewables and more -- that are altering the traditional electric utility industry. EnergyWire publishes daily at 9:00 a.m.

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Phone: 202-628-6500 Fax: 202-737-5299
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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, October 30, 2014 12:24 PM
To: Charles Lord
Subject: Granite Wash per RRC

http://www.rrc.state.tx.us/oil-gas/major-oil-gas-formations/granite-wash/

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, October 10, 2014 9:14 AM
To: Honker, William; Garcia, David; Brown, Jamesr
Cc: Graves, Brian; Frazier, Mike; Johnson, Ken-E; Lawrence, Rob; Bierschenk, Arnold
Subject: FW: 2014-10-10 13:51:21 (M4.3) OKLAHOMA 36.0 -96.8 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Friday, October 10, 2014 9:06 AM
To: Dorsey, Nancy
Subject: 2014-10-10 13:51:21 (M4.3) OKLAHOMA 36.0 -96.8 (63093)

M4.3 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.3
Date-Time	10 Oct 2014 13:51:21 UTC 10 Oct 2014 08:51:21 near epicenter 10 Oct 2014 06:51:21 standard time in your timezone
Location	35.964N 96.773W
Depth	4 km
Distances	2 km (1 mi) SSW of Cushing, Oklahoma 30 km (18 mi) ESE of Stillwater, Oklahoma 59 km (36 mi) W of Sapulpa, Oklahoma 59 km (36 mi) E of Guthrie, Oklahoma 86 km (53 mi) NE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 7.8 km
Parameters	Nph = 49; Dmin = 24.0 km; Rmss = 0.42 seconds; Gp = 43° Version =
Event ID	us b000skq4

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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https://sslearthquake.usgs.gov/ens/

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STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, October 09, 2014 11:10 AM
To: Frazier, Mike
Subject: RE: Wastewater Injection Spurred Biggest Earthquake Yet, Says Study - The Earth Institute - Columbia University

This is pretty old.

-----Original Message-----
From: Frazier, Mike
Sent: Thursday, October 09, 2014 10:47 AM
To: Dellinger, Philip; Dorsey, Nancy
Subject: Wastewater Injection Spurred Biggest Earthquake Yet, Says Study - The Earth Institute - Columbia University

http://www.earth.columbia.edu/articles/view/3072

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, October 02, 2014 1:16 PM
To: Dellinger, Philip
Cc: Frazier, Mike
Subject: per OGS

Importance: High

Origin Time (UTC)	Latitude	Longitude	Depth (km)	Magnitude
2014-10-02 14:14:39.088999	36.584 +/- 0.9	-97.818 +/- 1.6	6.0 +/- 3.4	2.3 ML OGS
2014-10-02 10:46:55.152000	35.817 +/- 0.6	-97.419 +/- 0.9	5.2 +/- 1.3	2.8 ML OGS

Nothing reported yet by USGS for today, in Oklahoma.

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, October 02, 2014 9:13 AM
To: Tim Baker; Charles Lord
Subject: FW: INDUCED SEISMICITY TASK FORCE SUBMITS SEISMIC ACTION PLAN TO GOVERNOR SAM BROWNBACK
Attachments: State Action Plan Cover Letter.pdf; Response_to_Comments_final.pdf; Response_to_Comments_2a (2).pdf; State_of_Kansas_Seismic_Action_Plan_9_26_14.pdf

In case you haven't seen this.

The plan for their GS to handle the first leg and provide the regulatory agencies the wells of concern could save you all a ton of work if OK adopted something similar. Just a thought. ☺

From: Hildebrandt, Kurt
Sent: Wednesday, October 01, 2014 4:59 PM
To: Dellinger, Philip; Dorsey, Nancy; Bates, William; Kobelski, Bruce; Bierschenk, Arnold; Johnson, Ken-E; Lawrence, Rob
Cc: Mindrup, Mary; Bergman, Ronald; Green, Holly
Subject: FW: INDUCED SEISMICITY TASK FORCE SUBMITS SEISMIC ACTION PLAN TO GOVERNOR SAM BROWNBACK

FYI – Hot off the email wire.

From: Jesse Borjon [mailto:j.borjon@kcc.ks.gov]
Sent: Wednesday, October 01, 2014 4:51 PM
To: Jesse Borjon
Subject: INDUCED SEISMICITY TASK FORCE SUBMITS SEISMIC ACTION PLAN TO GOVERNOR SAM BROWNBACK

News Release

For Immediate Release
Oct 1, 2014

Contact Information
Jesse Borjon (785) 271-3269

INDUCED SEISMICITY TASK FORCE SUBMITS SEISMIC ACTION PLAN TO GOVERNOR SAM BROWNBACK

Topeka, Kan. – A three-member task force established by Governor Brownback in February has submitted its action plan to the Governor.

"I created this task force to address public safety based on seismic activity we were seeing in south-central Kansas," said Governor Brownback. "I appreciate their hard work and look forward to reviewing the plan and its recommendations."

Governor Brownback established the State Task Force on Induced Seismicity with representation from the Kansas Geological Survey, the Kansas Corporation Commission, and the Kansas Department of Health and Environment. The Task Force met five times and held a public meeting in Wichita. Experts were consulted from the U.S. Geological Survey, the Oklahoma Geological Survey, and private industry. The Task Force developed a draft plan that was presented and discussed at a public meeting in Wichita, revised, and

resubmitted a second time for public comment. The final result is the plan being presented to Governor Brownback today.

“We appreciate Governor Brownback’s foresight in establishing a task force to look at induced seismicity,” said Rex Buchanan, Interim Director, Kansas Geological Survey. “The Action Plan takes into account both public safety and activities of the state’s oil and gas industry.”

Oil and gas is a cornerstone industry in Kansas generating nearly $4.3 billion each year, and employing 118,000 Kansans each day. The task force was directed to ensure the safety of all Kansans, and to consider the impacts to industry and the environment.

The Kansas Seismic Action Plan addresses the issue of induced seismicity, that is, earthquakes resulting from human activity. The plan provides background information citing national studies linking seismic activity to fluid injection; however, the task force had no conclusive evidence linking fluid injection to specific seismic events in Kansas.

The Seismic Action Plan consists of two major components – a plan for enhanced seismic monitoring and a response plan. Enhanced seismic monitoring includes installation of a strategically located permanent monitoring network that will allow all earthquakes in Kansas of a magnitude greater than 1.5 to be detected and located. Kansas currently has no state-supported seismic network. In addition, the plan recommends a portable seismic array that will allow the Kansas Geological Survey to deploy monitoring stations in areas with significant seismic activity to better understand the cause of localized earthquakes. The enhanced seismic monitoring component of the plan will collect important data resulting in a better understanding of the seismic activity over time.

The second component is a seismic response plan. A key component of the plan is a Seismic Action Score (SAS), a formula for evaluating seismic events that will guide an appropriate response by the Kansas Geological Survey, Kansas Corporation Commission, and Kansas Department of Health and Environment. The SAS formula provides a mechanism designed to trigger an agency response. The formula is subject to change as more data becomes available and scientifically credible information about induced seismicity is published.

Thus far in 2014, the U.S. Geological Survey’s National Earthquake Information Center has recorded 58 earthquakes, ranging from magnitude 1.3 to 3.8, nearly all in Sumner, Harper, and Barber counties. This is an increase over 2013 and prior years.

It is important to note that hydraulic fracturing (or “fracking”) should not be confused with the injection of salt water. In their 2012 report, the United States Geological Survey in stated there is “no evidence to suggest hydraulic fracturing itself is the cause of the increased rate of earthquakes in the midcontinent.”

###

Jesse Borjon, *Director*
Public Affairs and Consumer Protection
Kansas Corporation Commission
Phone (785) 271-3269

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, August 26, 2014 1:07 PM
To: Charles Lord; Tim Baker
Subject: FW: Questions remain at epicenter of quake trend | News OK

Have you seen this?

-----Original Message-----
From: Stenger, Wren
Sent: Tuesday, August 26, 2014 12:43 PM
To: Dellinger, Philip; Dorsey, Nancy
Subject: Questions remain at epicenter of quake trend | News OK

Phil, Nancy,
Check out this article in the Oklahoma paper. Interesting.

http://newsok.com/questions-remain-at-epicenter-of-quake-trend/article/5335366

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, August 25, 2014 10:54 AM
To: 'Ben Grunewald'
Subject: RE: Monitoring Subgroup - NEWS

Yup

From: Ben Grunewald [mailto:ben@gwpc.org]
Sent: Monday, August 25, 2014 9:30 AM
To: Ben Grunewald; Scott Ausbrooks; austin.holland@ou.edu; Gertson, Rod; Bauer, Robert A; Timothy_Tyrrell@xtoenergy.com; Linda McDonald; Dorsey, Nancy; Bates, William; Justin Rubinstein; ROVELLI, BRIAN (GE Global Research); smunews@smu.edu; ccabarcas@hilcorp.com; furnace@hilcorp.com; Craig.Pearson@rrc.state.tx.us
Cc: rex@kgs.ku.edu; Rick.Simmers@dnr.state.oh.us
Subject: Monitoring Subgroup - NEWS

See 2 items below…

Have you seen this from USGS???

http://earthquake.usgs.gov/regional/ceus/products/OKeqanimation.php

---

Study: Less shake from fake quakes
Fuel Fix, Fort Worth Star-Telegram, Longview News-Journal
August 18, 2014
By: Seth Borenstein, AP

WASHINGTON (AP) — Man-made earthquakes, a side effect of some high-tech energy drilling, cause less shaking and in general are about 16 times weaker than natural earthquakes with the same magnitude, a new federal study found.

People feeling the ground move from induced quakes — those that are not natural, but triggered by injections of wastewater deep underground— report significantly less shaking than those who experience more normal earthquakes of the same magnitude, according to a study by U.S. Geological Survey geophysicist Susan Hough.

Distance matters in this shaking gap, however. For people within 6 miles of the fault, artificial and natural quakes feel pretty much the same, she said.

Hough studied similar-sized man-made and natural quakes in the central and eastern United States from 2011 to 2013, comparing the reported magnitude to what people said they felt in the USGS electronic “Did You Feel It” survey. She found that while two different types of temblors may have had the same magnitude as measured by seismographs, they had distinct differences in what people said they felt.

The way artificial quakes felt was equivalent on average to a natural quake that had a magnitude 0.8 smaller. So a 4.8 induced quake felt like a 4.0 quake, Hough said. The magnitude scale used by USGS and others is mathematically complex, but a drop in 0.8 magnitude translates to about 16 times less strength or energy released.

Sometimes the difference is even bigger. Hough said a 5.3 August 2011 man-made quake in Trinidad, Colorado, actually felt like a 4.0 quake, which is about 90 times weaker, based on the thousands of responses in the “Did You Feel It” survey system. The study, published Monday in the Bulletin of the Seismological Society of America, looked at quakes in Oklahoma, Colorado, Arkansas, Texas and Ohio. It included a 5.7 quake in Prague, Oklahoma, in November 2011 that injured two people and damaged 14 houses, which Hough said felt like 5.1 magnitude natural quake.

“The hazard of these earthquakes is lower than what you’d expect,” Hough said. “It’s not that there’s no hazard, it’s just that it’s a little better than you might think.”

Man-made earthquakes have become a big concern recently as hydraulic fracturing, or fracking, and other drilling injects wastewater deep underground. Scientists say that sometimes triggers shifts along existing and previously unknown faults. Oklahoma has had more than 300 earthquakes of magnitude 3 or more — strong enough to feel locally but too weak to cause damage — since Jan. 1. Before 2007, Oklahoma averaged only one quake a year of that size.

The artificial quakes may have less energy because the fault is lubricated by the injected wastewater, making it easier to slip, Hough theorized.

THANKS –Ben
405 516 4972

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, August 20, 2014 8:29 AM
To: Bates, William; Bierschenk, Arnold; Dellinger, Philip; Hildebrandt, Kurt; Johnson, Ken-E; Kobelski, Bruce; Lawrence, Rob
Subject: FW: This is an online preprint publication. Do you think you can get a copy of it please?
Attachments: Shaking from Injection-Induced Earthquakes in the Central and Eastern United States.pdf

---

From: Morris, Abigail
Sent: Tuesday, August 19, 2014 4:14 PM
To: Dorsey, Nancy
Subject: RE: This is an online preprint publication. Do you think you can get a copy of it please?

Nancy- They were super-fast, I assumed it wouldn't come until after I left today. Here's the article. Please let me know if you need anything else.

Thanks-

Abby Morris Librarian I, Document Systems Incorporated, a contractor for the EPA
US EPA Region 6 Library
214-665-6424
morris.abigail@epa.gov

Tell us how we're doing - rate our customer service!
http://www.surveymonkey.com/s/epalibsurvey

From: Dorsey, Nancy
Sent: Tuesday, August 19, 2014 2:42 PM
To: Morris, Abigail
Subject: This is an online preprint publication. Do you think you can get a copy of it please?

Shaking from Injection-Induced Earthquakes in the Central and Eastern United States *Bulletin of the Seismological Society of America published ahead of print August 19, 2014,*

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, August 12, 2014 4:23 PM
To: Lawrence, Rob; Johnson, Ken-E; Dellinger, Philip; Overbay, Michael
Cc: Bates, William; Kobelski, Bruce
Subject: RE: Aug 7 -- BNA, Inc. Daily Environment Report - OK lawsuits over disposal wells and induced seismicity

It was only a matter of time. I wonder what court this will appear in?

From: Lawrence, Rob
Sent: Tuesday, August 12, 2014 4:04 PM
To: Dorsey, Nancy; Johnson, Ken-E; Dellinger, Philip; Overbay, Michael
Cc: Bates, William; Kobelski, Bruce
Subject: FW: Aug 7 -- BNA, Inc. Daily Environment Report - OK lawsuits over disposal wells and induced seismicity

FYI

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Weiler, Gregory
Sent: Tuesday, August 12, 2014 3:49 PM
To: Shar, Alan; Thilsted, Eugene; Lawrence, Rob
Subject: FW: Aug 7 -- BNA, Inc. Daily Environment Report - Afternoon Briefing

Greg Weiler
Pesticides Section
214-665-7564
weiler.gregory@epa.gov

"Farming looks mighty easy when your plow is a pencil, and you're a thousand miles from the corn field" -- President Dwight D. Eisenhower

---

From: Acosta, Gerardo
Sent: Thursday, August 07, 2014 3:52 PM
To: Broadnax, Sheila; Carroll, Craig; Collins, Jerry; Dunbar, Kristin; McMillan, Lee; McPherson, Kenneth; Reyes, Elizabeth; Ruple, Chuck; Sieminski, Blake; Weiler, Gregory
Subject: FW: Aug 7 -- BNA, Inc. Daily Environment Report - Afternoon Briefing

FYI – watch out!

Earthquakes Prompt Citizen Lawsuit Against Multiple Drillers in Oklahoma

Posted August 07, 2014, 3:07 P.M. ET

By Paul Stinson

An Oklahoma resident injured during a 2011 outbreak of earthquakes in central Oklahoma is suing multiple energy companies for punitive damages, alleging her injuries were the “direct result of man-made earthquakes” stemming from the use of wastewater injection wells.

Sandra Ladra, a resident of Prague, Okla., filed a complaint Aug. 4 asking the Lincoln County District Court for a minimum of $75,000 damages, seeking relief from Cleveland, Okla.-based Spess Oil Co. and Tulsa, Okla.-based New Dominion LLC, in addition to 25 “John Doe” entities that have engaged in injection well operations in the central part of the state.

A town of approximately 2,100, Prague was the site of a 5.6 magnitude earthquake in November 2011.

Following a 33-year period from 1975 that produced 56 earthquakes of magnitude 3.0 or greater, Oklahoma has become the most seismically active state in the continental U.S.

According to Oklahoma Geological Survey data, the state has experienced approximately 538 earthquakes over the last six years, including 260 so far in 2014—more than double the previous high of 109 set in 2013.

From: BNA Highlights [mailto:bhighlig@bna.com]
Sent: Thursday, August 07, 2014 2:44 PM
To: Acosta, Gerardo
Subject: Aug 7 -- BNA, Inc. Daily Environment Report - Afternoon Briefing

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, August 06, 2014 8:41 AM
To: Charles Lord; Tim Baker; Bates, William; Bierschenk, Arnold; Dellinger, Philip; Hildebrandt, Kurt; Johnson, Ken-E; Kobelski, Bruce; Lawrence, Rob
Cc: R6 6WQ-SG
Subject: Legislator, geologist trying to create 'emergency plan' to address Oklahoma earthquakes

http://kfor.com/2014/08/04/legislator-geologist-trying-to-create-emergency-plan-to-address-oklahoma-earthquakes/

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, August 04, 2014 12:46 PM
To: Charles Lord; Tim Baker
Subject: BNA: From Oklahoma to Ohio, States Take Measures to Quell Quakes Related to Drilling

http://news.bna.com/deln/DELNWB/split_display.adp?fedfid=50744539&vname=dennotallissues&jd=a0f3y7y9k8&split=0

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, July 29, 2014 7:50 AM
To: Dellinger, Philip; Johnson, Ken-E; Brown, Jamesr; Lawrence, Rob
Subject: FW: 2014-07-29 02:46:36 (M4.0) OKLAHOMA 36.7 -98.0 (63093) another 4.0 near Medford

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Monday, July 28, 2014 10:01 PM
To: Dorsey, Nancy
Subject: 2014-07-29 02:46:36 (M4.0) OKLAHOMA 36.7 -98.0 (63093)

M4.0 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.0
Date-Time	29 Jul 2014 02:46:36 UTC 28 Jul 2014 21:46:36 near epicenter 28 Jul 2014 19:46:36 standard time in your timezone
Location	36.732N 97.987W
Depth	7 km
Distances	24 km (14 mi) WSW of Medford, Oklahoma 38 km (23 mi) NNW of Enid, Oklahoma 80 km (49 mi) W of Ponca City, Oklahoma 92 km (57 mi) WSW of Arkansas City, Kansas 146 km (90 mi) NNW of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 6.4 km
Parameters	Nph = 39; Dmin = 25.5 km; Rmss = 0.73 seconds; Gp = 80° Version =
Event ID	us b000ry6y

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

Disclaimer

This email was sent to dorsey.nancy@epa.gov

You requested mail for events within the 'R6 plus CO' region
for M1.0 between 08:00 and 20:00 and M1.5 other times.

To change your parameters, go to:

https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, July 28, 2014 1:30 PM
To: Charles Lord; Tim Baker
Subject: more links that may be of interest

And more links related to same EQ article
http://www.chron.com/news/texas/article/Answers-on-link-between-injection-wells-and-quakes-5620961.php#photo-6595356

Different topics
http://stateimpact.npr.org/oklahoma/2014/07/14/oklahoma-officials-may-reconsider-keeping-oil-train-shipments-secret/

http://www.eenews.net/energywire/2014/07/16/stories/1060002911 Okla. agency gets $1.8M to study seismic links to drilling

From the daily news update, a story from Oklahoma:

> A geologist with one of the country's largest independent oil producers will talk about the recent uptick in earthquake activity in Oklahoma.
>
> Continental Resources' Vice President of Geology Glen Brown will deliver a luncheon address Wednesday to members of the Oklahoma Geological Society.
>
> Brown theorizes that the increase in seismic activity across the state may be related to larger worldwide earthquakes. He says unusual earthquake activity has been observed in recent years in other states where there is no oil and gas activity.
>
> According to the U.S. Geological Survey, Oklahoma has recorded about 250 small-to-medium earthquakes since January.
>
> A study published earlier this month in the journal Science suggests water being pumped into wastewater injection wells is responsible for many of the quakes.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, July 28, 2014 10:15 AM
To: Charles Lord; Tim Baker
Subject: FW: 7 earthquakes in OK over the weekend. CNN did a story linking them to injection wells

I assume you have already seen this….and are running even faster. Sigh.

From: Overbay, Michael
Sent: Monday, July 14, 2014 9:51 AM
To: Honker, William; Garcia, David; Brown, Jamesr
Cc: R6 6WQ-SG
Subject: 7 earthquakes in OK over the weekend. CNN did a story linking them to injection wells

http://www.cnn.com/2014/07/13/us/oklahoma-earthquakes/index.html?hpt=hp_t2

Michael Overbay, P.G.
Regional Ground Water Center Coordinator
US Environmental Protection Agency, Region 6
(214)665-6482

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, July 07, 2014 10:15 AM
To: Charles Lord; Tim Baker
Subject: FW: science mag
Attachments: science_mag_OK_earthquakes.pdf

Importance: High

I assume you have seen this article?

From: Lawrence, Rob
Sent: Monday, July 07, 2014 9:04 AM
To: Dellinger, Philip; Overbay, Michael; Bates, William; Dorsey, Nancy; Johnson, Ken-E
Subject: FW: science mag

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Gray, David
Sent: Monday, July 07, 2014 8:52 AM
To: Lawrence, Rob
Subject: science mag

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, June 30, 2014 10:28 AM
To: Bates, William; Bierschenk, Arnold; Dellinger, Philip; Johnson, Ken-E; Kobelski, Bruce; Lawrence, Rob
Cc: Brown, Jamesr; Dwyer, Stacey
Subject: OCC official line on induced seismicity

http://www.occeweb.com/OCC_SESMICITY5.pdf

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, June 27, 2014 2:35 PM
To: Charles Lord; Tim Baker
Subject: FW: Guthrie earthquake townhall meeting

I assume you have seen these.

From: Dorsey, Nancy
Sent: Friday, June 27, 2014 8:36 AM
To: R6 6WQ-SG; R6 6WQ-S; Lawrence, Rob
Cc: Dwyer, Stacey; Bates, William; Kobelski, Bruce
Subject: Guthrie earthquake townhall meeting

http://newsok.com/edmond-earthquake-town-hall-leaves-attendees-unsatisfied/article/4972923
http://kfor.com/2014/06/26/earthquake-town-hall-meeting-tonight-addresses-oklahomans-concerns/
http://www.okcfox.com/story/25884158/earthquake-town-hall-meeting-gets-heated

Hundreds of Oklahomans gather for earthquake town hall meeting to get answers

Posted 7:06 am, June 26, 2014, by Laura Noland KFOR-TV, Dallas Franklin and KFOR-TV and La'Tasha Givens, Updated at 07:38am, June 27, 2014

EDMOND, Okla. – With the latest increase of quakes, furious Oklahomans are demanding to know why.

Hundreds gathered for a town hall meeting in Edmond Thursday night to get some answers.

Seismologists say Oklahoma has more earthquakes than states further west.

Experts say for 30 years our state averaged 1.5 earthquakes a day, but since January, we've had 231 quakes with a 3.0 magnitude or higher.

Experts also say they understand the concerns about fracking and waste water wells causing the earthquakes.

They believe there might be a correlation.

However, it would still not explain the clusters of quakes in the Jones area where no fracking is taking place.

Many asked why companies just won't take a break from fracking and using waste water wells. Experts said if those activities stop then they won't be able to continue studying the issue and Oklahoma could lose viable sources of income without just cause.

Many residents left the meeting without any clear answers.

If you were unable to attend the meeting, but would like access to the various materials presented at the meeting, call (405)557-7350.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, June 27, 2014 8:36 AM
To: R6 6WQ-SG; R6 6WQ-S; Lawrence, Rob
Cc: Dwyer, Stacey; Bates, William; Kobelski, Bruce
Subject: Guthrie earthquake townhall meeting

http://newsok.com/edmond-earthquake-town-hall-leaves-attendees-unsatisfied/article/4972923
http://kfor.com/2014/06/26/earthquake-town-hall-meeting-tonight-addresses-oklahomans-concerns/
http://www.okcfox.com/story/25884158/earthquake-town-hall-meeting-gets-heated

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If you were unable to attend the meeting, but would like access to the various materials presented at the meeting, call (405)557-7350.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, June 25, 2014 8:30 AM
To: Bates, William
Cc: Brown, Jamesr; Dwyer, Stacey; Garcia, David
Subject: FW: EARTHQUAKES: EPA has yet to release 'final' report on quakes and drilling

In case you haven't seen this.

From: Lawrence, Rob
Sent: Wednesday, June 25, 2014 7:53 AM
To: Dorsey, Nancy; Overbay, Michael; Johnson, Ken-E
Cc: susie.mckenzie@denbury.com
Subject: FW: EARTHQUAKES: EPA has yet to release 'final' report on quakes and drilling

FYI

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Casso, Ruben
Sent: Wednesday, June 25, 2014 7:45 AM
To: Lawrence, Rob; Dellinger, Philip
Subject: EARTHQUAKES: EPA has yet to release 'final' report on quakes and drilling

EARTHQUAKES: EPA has yet to release 'final' report on quakes and drilling

Mike Soraghan, E&E reporter

Published: Wednesday, June 25, 2014

The U.S. EPA team looking into man-made earthquakes linked to drilling activities sent a final report to headquarters in Washington, D.C., several months ago. But the report still has not been officially released.

The version sent to Washington in January changes the wording for how to deal with problem wells when earthquakes persist. The phrase "do not operate," used in a prior draft, was replaced with "conditions not conducive to injection" (*EnergyWire*, July 22, 2013).

And the report did not recommend that all disposal wells be tested for seismic dangers. Because of that, one member of the working group that drafted the report voted against it.

"The authors and I are not comfortable in having the work product recommend seismic monitoring for every Class IID well across the country, as there are just too many variables that exist," wrote the chairman of the group, Kurt Hildebrandt, with EPA's Underground Injection Control (UIC) program in EPA Kansas City-based Region 7.

The version sent to Washington -- deemed "final" in a transmittal memo -- was included in a response to a Freedom of Information Act request by *Inside EPA* in March.

The workgroup effort began quietly in June 2011. At the time, EPA officials said "the UIC program can and should implement requirements to protect against significant seismic events."

But agency leaders have also stressed that group was not seeking to make new policies or regulations. Instead, it was to develop recommendations for state officials for dealing with injection wells linked to earthquakes. The study was to have been completed by December 2011 but wasn't.

Oil and gas regulation can be a touchy subject at EPA. The agency has been under intense criticism from the oil and gas industry and congressional Republicans as it weighs its role in the nation's shale boom.

Environmentalists have criticized the agency for pulling back from three major water contamination cases in Pennsylvania, Texas and Wyoming. Some groups are wary of President Obama's "all of the above" energy strategy, which includes domestic oil and gas production.

Scientists have known for decades that underground injection of fluid can lubricate faults and unleash earthquakes. Some seismologists now think the boom in shale drilling in the United States -- and the wastewater it produces -- might be causing a sharp increase in the number of earthquakes in the middle of the country.

Researchers have linked such deep injection wells to earthquakes in Arkansas, Colorado, Ohio, Oklahoma and Texas. More "earth-friendly" procedures, such as geothermal energy production and carbon sequestration, can also set the earth rumbling.

Oil and gas production is regulated almost entirely by states. But a federal law, the Safe Drinking Water Act, governs underground disposal of drilling wastewater. EPA regulates disposal directly in a few states, such as Pennsylvania, but in most it has handed day-to-day regulation to state agencies.

The Safe Drinking Water Act doesn't make it illegal to cause an earthquake. Instead, EPA seeks to prevent earthquakes because they might harm the underground sources of drinking water the act does protect.

Click here to see the latest version of the report.

Click here to see the memo transmitting the report to Washington.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, June 18, 2014 10:35 AM
To: R6 6WQ-SG; R6 6WQ-SD; Honker, William; Garcia, David
Subject: Oklahoma earthquake tracking links and news anchors live response

http://earthquaketrack.com/us-ok-edmond/recent

http://mashable.com/2014/06/16/oklahoma-earthquake/

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, June 18, 2014 7:58 AM
To: Dellinger, Philip; Johnson, Ken-E; Lawrence, Rob; Graves, Brian
Cc: Bates, William
Subject: 4.3 near Edmond
Attachments: 2014-06-17 14:36:36 (M2.6) OKLAHOMA 36.7 -97.7 (63093); 2014-06-16 19:00:47 (M2.7) OKLAHOMA 35.6 -97.3 (63093); 2014-06-17 04:11:45 (M2.7) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.4 (63093); 2014-06-17 04:57:40 (M2.7) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.4 (63093); 2014-06-18 07:08:02 (M3.0) OKLAHOMA 35.9 -97.2 (63093); 2014-06-18 10:30:18 (M2.7) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.4 (63093); 2014-06-18 10:53:02 (M4.3) OKLAHOMA 35.6 -97.4 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, June 16, 2014 8:10 AM
To: Dellinger, Philip; Graves, Brian; Johnson, Ken-E; Lawrence, Rob
Subject: 4.2 followed by 3.0 Jones, OK
Attachments: 2014-06-16 11:25:13 (M3.0) OKLAHOMA 35.6 -97.4 (63093); 2014-06-16 10:47:35 (M4.2) OKLAHOMA 35.6 -97.3 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, June 05, 2014 3:09 PM
To: R6 6WQ-SG; Brown, Jamesr
Cc: Lawrence, Rob; Bates, William
Subject: Local legislators to host earthquake Town Hall - Guthrie Oklahoma

http://guthrienewspage.wordpress.com/2014/04/21/earthquake-town-hall-meeting/

Earthquake town hall meeting

April 21, 2014Chris EvansLeave a commentGo to comments

SHARE

There has been overwhelming interest expressed in a town hall meeting to address the recent earthquake swarms which have been plaguing this area of the state. People are naturally concerned, and they want answers.

State Reprenstative Jason Murphey

Based on the voluminous feedback I've received, State Representative Lewis Moore and I will host the town hall meeting. Moore is a fellow member of the Edmond legislative delegation and he represents House District 96 and much of northeastern Oklahoma County which has also experienced its share of quakes. We will try to host the meeting where it will be easy for residents of both districts to attend. We are currently working to establish a location and time which we intend to announce shortly.

Corporation Commission officials have agreed to speak at the meeting about the state's response to the quakes and the Commission's work to monitor the wastewater injection wells, which many believe have a correlational

relationship to the quakes.

I hope you will attend this meeting. Here's a small sample of what I expect will be talked about.

The Commission uses a three-tier system for permitting the ongoing operations of injection sites. They have a green, yellow and red designation with the colors corresponding to the specific situation at an injection site. As I understand it, green means all is fine and injections can proceed as normal, yellow is a cautionary state where injections may need to be scaled back, and red indicates that perhaps the site should be shut down.

A few months ago, a Love County injection site operator voluntarily supplied pressure data from two of his sites. Based on this data, the Commission found a correlation between the injections and seismic activity. They transitioned the Love County sites from a green designation to a yellow designation. At that time, the site operator voluntarily suspended operations.

The Commission recently mandated that this same data be provided by many of the other injection sites, including some in this area. That mandate is scheduled to take effect soon. However, even before the mandate starts, the data is already being provided from the site close to the Liberty Lake quake swarm.

That means this latest quake swarm can be studied by state geology officials using the new data from this site. They may decide that a correlation exists between the current ongoing Quakes and the injections. Should that be the case, the Commission could take action to scale back the operations of the sites.

It's important to know that the Commission cannot act in an arbitrary or capricious manner because their decision-making process must be factual and data based or it could be overturned in court. There isn't a lot of court-based precedent for these matters yet and the Commission must carefully follow protocol and best practice.

Rep. Moore and I will give the Commission and geology officials a little time to study the data prior to our town hall meeting so they can provide us with the most up-to-date information. Based on the data, the Commission could transition area sites to yellow status before the meeting occurs, but we will still host the meeting.

In addition to the town hall meeting, next month I will ask for a legislative interim hearing into this matter. If approved, the hearing will allow the Legislature to take testimony as we prepare for the filing of new bills later this year.

Thank you for reading this article. Your interest and input are much appreciated. Please do not hesitate to email Jason.Murphey@hd31.orgwith your thoughts and suggestions.

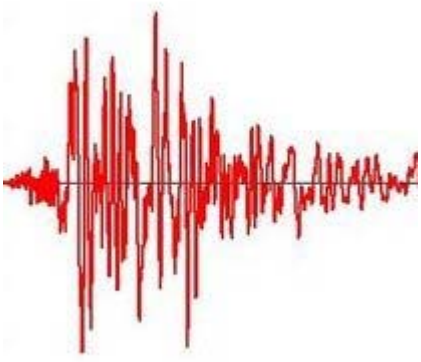
http://guthrienewspage.wordpress.com/category/state-government/

Local legislators to host earthquake Town Hall

June 5, 2014Chris EvansLeave a comment

Area state representatives Lewis Moore, R-Arcadia and Jason Murphey, R-Guthrie will host a town hall meeting at

7pm on the evening of June 26th inside of the Waterloo Road Baptist Church located at 3100 E. Waterloo Road in Edmond.



The meeting will feature presentations from the Oklahoma Corporation Commission and Oklahoma Geological Survey and will allow attendees to ask questions regarding the recent earthquake swarms which have been prominent in the Logan and Oklahoma county area.

“We want to provide the opportunity for the members of our constituency to have a direct line of communication to the state officials who are monitoring the seismic activities. I am grateful to the state officials who are willing to respond to the questions from area residents hope all interested individuals will be able to attend,” Murphey stated.

“This is a great opportunity for area residents to express their thoughts and concerns and learn more about the specifics of this issue,” explained Moore. “State officials have expressed a willingness to answer every question.”

Those who cannot attend, but would still like access to the various materials presented at the meeting should contact Murphey’s office at 557-7350.

Thank you for reading this article. Your interest and input are much appreciated. Please do not hesitate to email Jason.Murphey@hd31.org with your thoughts and suggestions.

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, May 09, 2014 4:24 PM
To: Garcia, David; Dellinger, Philip; Dwyer, Stacey
Cc: Johnson, Ken-E; Lawrence, Rob
Subject: FW: 2014-05-09 18:52:47 (M3.9) OKLAHOMA 36.6 -97.6 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Friday, May 09, 2014 2:07 PM
To: Dorsey, Nancy
Subject: 2014-05-09 18:52:47 (M3.9) OKLAHOMA 36.6 -97.6 (63093)

M3.9 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.9
Date-Time	9 May 2014 18:52:47 UTC 9 May 2014 13:52:47 near epicenter 9 May 2014 11:52:47 standard time in your timezone
Location	36.561N 97.595W
Depth	4 km
Distances	28 km (17 mi) WSW of Tonkawa, Oklahoma 31 km (19 mi) NE of Enid, Oklahoma 48 km (29 mi) WSW of Ponca City, Oklahoma 69 km (42 mi) NW of Stillwater, Oklahoma 121 km (75 mi) N of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 5.7 km
Parameters	Nph = 81; Dmin = 35.7 km; Rmss = 0.85 seconds; Gp = 27° Version =
Event ID	us b000qfz9

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey

http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, May 07, 2014 5:03 PM
To: Charles Lord; Tim Baker
Subject: FW: Animation of Oklahoma Earthquakes: January 2, 2008 - April 30, 2014 from USGS

Making the rounds!

From: Mayer, Rebecca
Sent: Wednesday, May 07, 2014 2:24 PM
To: Taheri, Diane; Gray, David; Dellinger, Philip
Cc: McCorkhill, Michael; Durant, Jennah; Hubbard, Joseph; Dorsey, Nancy
Subject: Animation of Oklahoma Earthquakes: January 2, 2008 - April 30, 2014 from USGS

FYI. This animation was tweeted out by State Impact Texas.

http://earthquake.usgs.gov/regional/ceus/products/OKeqanimation.php

StateImpact Texas @StateImpactTX 7m
RT @jimbluewind: Stunning USGS Animation of Oklahoma Seismicity: January 2, 2008 - April 30, 2014 earthquake.usgs.gov/regional/ceus/…

Rebecca Mayer
Public Affairs Specialist
U.S. Environmental Protection Agency, Region 6
Office of External Affairs
214-665-7302

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, May 06, 2014 9:45 AM
To: Charles Lord; Tim Baker
Subject: recent articles - I am sure you have already seen
Attachments: FW: EARTHQUAKES: USGS continues probe of oil-and-gas link; water levels ruled out ; FW: EARTHQUAKES: Oklahoma City seismic swarm linked to 4 disposal wells -- study

Then there is this one…? The meeting in Memphis should be interesting!!!

FYI. Thought you might find this article interesting. We now have a new "handle" to include in our speeches: "fracquakes", in addition to "moving forward" and "you know". (Well, that is my appreciation, any way).

http://thinkprogress.org/climate/2014/05/02/3433793/stronger-frackquakes-on-the-way/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, May 06, 2014 9:40 AM
To: Torres, Jose
Subject: RE: On Seismicity

Oh my!

From: Torres, Jose
Sent: Monday, May 05, 2014 9:01 AM
To: R6 6WQ-SG
Subject: On Seismicity

FYI. Thought you might find this article interesting. We now have a new "handle" to include in our speeches: "fracquakes", in addition to "moving forward" and "you know". (Well, that is my appreciation, any way).

http://thinkprogress.org/climate/2014/05/02/3433793/stronger-frackquakes-on-the-way/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, May 02, 2014 8:39 AM
To: Lawrence, Rob
Subject: RE: EARTHQUAKES: USGS continues probe of oil-and-gas link; water levels ruled out

Wow, I don't disagree with any of Bill Ellsworth's quotes. Maybe that means they were correct (be the reporter)?

From: Lawrence, Rob
Sent: Thursday, May 01, 2014 3:32 PM
To: Dorsey, Nancy; Johnson, Ken-E; Graves, Brian
Subject: FW: EARTHQUAKES: USGS continues probe of oil-and-gas link; water levels ruled out

FYI

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Casso, Ruben
Sent: Thursday, May 01, 2014 3:20 PM
To: Lawrence, Rob; Dellinger, Philip
Subject: EARTHQUAKES: USGS continues probe of oil-and-gas link; water levels ruled out

EARTHQUAKES: USGS continues probe of oil-and-gas link; water levels ruled out

Mike Soraghan, E&E reporter

Published: Thursday, May 1, 2014

U.S. Geological Survey scientists have ruled out changing water table levels as the cause of a swarm of small earthquakes in North Texas late last year, but they haven't ruled out natural causes.

"It could be a rare but natural event," said Bill Ellsworth, who spoke today at the annual meeting of the Seismological Society of America in Anchorage, Alaska.

Deep underground injection of oil and gas waste fluid "is considered one of the viable" possibilities, Ellsworth said. "We're still in the early stages."

Oil and gas production activities haven't been ruled out, either, Ellsworth said. That would include hydraulic fracturing. But he said USGS scientists lack much of the data they need about oil and gas activities in the area.

Azle and Reno, Texas, northwest of Fort Worth, were shaken by more than 30 earthquakes in November and December of last year, including eight registering magnitude 3.0 or stronger. No injuries or serious damage was reported. USGS says they were the first earthquakes recorded in the area since 1973.

Many residents have pointed the finger at injection wells in the area. There are several injection wells in the area. According to a summary authored by Ellsworth, one of them has injected more than 1.5 billion gallons of waste fluid since 2009.

Many of those residents have been upset by the slow reaction of the Texas Railroad Commission, which oversees oil and gas in the state. An angry crowd of about 850 people turned out for a Jan. 2 meeting with Railroad Commission staff.

Railroad Commission officials have questioned the link between injection wells and earthquakes, and they said they can't shut down injection wells because of earthquakes. But the agency did recently hire a seismologist.

Texas legislators have scheduled a hearing for later this month about the quakes (*EnergyWire*, April 2).

Ellsworth said his research has shown that the quakes were occurring on a known fault that was active millions of years ago. The last known earthquake in the area was in 1950, and only one person reported feeling it.

Since 2008, there have been 70 earthquakes in the area, he said, calling that "a major change."

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, May 02, 2014 8:37 AM
To: Lawrence, Rob; Johnson, Ken-E; Graves, Brian
Subject: RE: Study links wastewater injection, Oklahoma quake in 2011

It may be a new publication but the research is not new, just the same study rehashed.

From: Lawrence, Rob
Sent: Thursday, May 01, 2014 4:02 PM
To: Dorsey, Nancy; Johnson, Ken-E; Graves, Brian
Subject: FW: Study links wastewater injection, Oklahoma quake in 2011

FYI

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: Casso, Ruben
Sent: Thursday, May 01, 2014 3:37 PM
To: Lawrence, Rob; Dellinger, Philip
Subject: Study links wastewater injection, Oklahoma quake in 2011

Study links wastewater injection, Oklahoma quake in 2011

File 2011/The Associated Press
Maintenance workers inspected the damage to one of the spires on Benedictine Hall at St. Gregory's University following a magnitude-5.7 earthquake in Shawnee, Okla. New research suggests the quake, the sharpest to strike Oklahoma, may have been triggered in part by wastewater injection, which, if true, would make the 2011 temblor the strongest ever linked to disposal practices within the oil and gas industry.

BAILEY ELISE McBRIDE

BAILEY ELISE McBRIDEThe Dallas Morning News

Associated Press

Published: 01 May 2014 01:59 PM

Updated: 01 May 2014 03:09 PM

OKLAHOMA CITY — New research suggests that the sharpest earthquake to strike Oklahoma may have been triggered in part by wastewater injection — which if true, would make the 2011 temblor the strongest ever linked to disposal practices within the oil and gas industry.

An industry spokesman says a cause-and-effect cannot be proven because work in the oil patch hasn’t changed much in generations. A study of the same quake last year noted that wastewater had been injected into abandoned oil wells nearby for 17 years without incident.

The magnitude 5.7 quake, centered near Prague, knocked over four spires at a university 17 miles away and shook a college football stadium that moments earlier had held more than 57,000 fans. Fourteen homes suffered significant damage and two people near the epicenter suffered minor injuries. The quake caused at least $4.5 million in damages.

A study published in March in the Journal of Geophysical Research, written by scientists from Brown and Cornell universities, the Lamont Doherty Earth Observatory at Columbia University, the University of Southern California and the U.S. Geological Survey, concentrated on Oklahoma quakes in the fall of 2011. The state has had thousands of smaller temblors since.

The lead researcher, Danielle Sumy, a postdoctoral student at Southern California and a former USGS geologist, said a magnitude-5.0 quake triggered by wastewater injection early on Nov. 6, 2011, set off subtle pressures that rolled along like dominoes before finding relief in the 5.7 temblor later that day.

“We found that this magnitude 5.0 earthquake did increase the stress in the region around the 5.7 magnitude earthquake, thus allowing a cascade of failure along the fault,” Sumy said.

A recent study linking hydraulic fracturing — the process in which water mixed with sand and chemicals is used to extract oil and gas — to quakes in Appalachia led Ohio agencies to issue new regulations. In Oklahoma, the focus is on the industry’s wastewater, which is often injected into old oil wells for disposal, not on fracking.

“These earthquakes had absolutely nothing to do with hydraulic fracturing, we can say that with confidence,” said Austin Holland, a research seismologist with the Oklahoma Geological Survey, which was not involved in the study. “They may be related to wastewater disposal, but we don’t know. It’s a challenge to separate these things when we can’t see inside the earth.”

Until 2009, Oklahoma averaged about 50 small earthquakes a year. The U.S. Geological Survey says the state is now the most second most-active seismically, behind California. It’s had 116 earthquakes recorded in the last week alone, according to the Oklahoma Geological Society.

Since the infamous New Madrid quakes of 1811-12, the Prague temblor was the second-strongest east of the Rocky Mountains, behind the 5.8-magnitude quake in Virginia that damaged the Washington Monument in 2011.

Until the set of Nov. 5, 2011, quakes, Oklahoma’s last magnitude 5.0 temblor occurred in 1952.

Officials from the Geological Survey say they’re open to the idea that human actions may have caused the increase, but that it could also be completely natural — they just don’t have enough conclusive evidence.

Brian Woodward, the vice president of regulatory affairs for the Oklahoma Independent Petroleum Association, said the industry was working with researchers but that the recent increase in earthquake activity cannot necessarily be blamed on the state’s top industry.

“Granted, we’ve not seen this level of seismic activity in Oklahoma in the last 60 to 80 years and before that we don’t have a record. It causes us all concern, but the rush to correlate this activity with our industry is something we don’t believe is necessarily fair,” he said.

“Our industry has not fought back on proposed regulations and doing more data collection with the geological survey, and we support additional seismic [monitoring].”

More property owners in Oklahoma are purchasing earthquake insurance. State Farm Insurance spokesman Jim Camoriano said 5.5 of the company’s Oklahoma policyholders were covered prior to the Prague quake, but that the number jumped to 10 percent within two months. Now it’s 16 percent, he said.

Joe Reneau, a rancher from Prague, said he believed he was adequately compensated for the destruction of his home, but that neighbors suffered for years.

“I think there were very few that had earthquake insurance and people are still struggling,” Reneau said. “I go by a house on old Highway 62 that was just now being torn down — the people there had been living in it this whole time.”

Sumy said she had little doubt that human activity influenced the 2011 quake.

“As a scientist I have to remain objective … but I think with the prevalence of these earthquakes … all seem to be in proximity to wastewater fluid injection,” Sumy said

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, May 01, 2014 8:12 AM
To: Dellinger, Philip; Graves, Brian; Johnson, Ken-E; Lawrence, Rob
Subject: FW: 2014-05-01 10:04:08 (M3.6) OKLAHOMA 35.8 -96.9 (63093)

Getting up there!

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Thursday, May 01, 2014 5:19 AM
To: Dorsey, Nancy
Subject: 2014-05-01 10:04:08 (M3.6) OKLAHOMA 35.8 -96.9 (63093)

M3.6 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.6
Date-Time	1 May 2014 10:04:08 UTC 1 May 2014 04:04:08 near epicenter 1 May 2014 03:04:08 standard time in your timezone
Location	35.817N 96.935W
Depth	5 km
Distances	13 km (8 mi) NNW of Chandler, Oklahoma 34 km (21 mi) SSE of Stillwater, Oklahoma 44 km (27 mi) E of Guthrie, Oklahoma 46 km (28 mi) NE of Choctaw, Oklahoma 65 km (40 mi) NE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 77; Dmin = 30.8 km; Rmss = 0.62 seconds; Gp = 21° Version =
Event ID	us b000q694

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
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U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, April 18, 2014 12:46 PM
To: 'Charles Lord'; 'Tim Baker'
Subject: FW: Oklahoma Swamped by Surge in Earthquakes Near Fracking

---

From: Dorsey, Nancy
Sent: Friday, April 18, 2014 12:44 PM
To: R6 6WQ-S; R6 6WQ-SG; Garcia, David; Lawrence, Rob; Bates, William
Subject: Oklahoma Swamped by Surge in Earthquakes Near Fracking

- Oklahoma Swamped by Surge in Earthquakes Near Fracking – April 8, 2014

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, April 17, 2014 2:17 PM
To: 'Charles Lord'; 'Tim Baker'
Subject: NPR report

I assume you have seen this and the one on Disposal Wells (there is a link in the article):
http://stateimpact.npr.org/oklahoma/2014/04/17/oklahoma-oil-and-gas-regulator-uses-red-tape-not-rules-to-manage-disposal-wells-in-earthquake-country/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, April 10, 2014 8:12 AM
To: Dellinger, Philip; Graves, Brian; Johnson, Ken-E
Subject: FW: 2014-04-10 07:33:57 (M4.1) OKLAHOMA 35.8 -97.5 (63093)

12 earthquakes reported in Oklahoma (2.3-4.1) since yesterday afternoon.

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Thursday, April 10, 2014 2:53 AM
To: Dorsey, Nancy
Subject: 2014-04-10 07:33:57 (M4.1) OKLAHOMA 35.8 -97.5 (63093)

M4.1 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.1
Date-Time	10 Apr 2014 07:33:57 UTC 10 Apr 2014 02:33:57 near epicenter 10 Apr 2014 00:33:57 standard time in your timezone
Location	35.791N 97.471W
Depth	3 km
Distances	10 km (6 mi) SSW of Guthrie, Oklahoma 15 km (9 mi) N of Edmond, Oklahoma 32 km (19 mi) NNE of Warr Acres, Oklahoma 33 km (20 mi) NNE of Bethany, Oklahoma 36 km (22 mi) N of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 6.7 km
Parameters	Nph = 99; Dmin = 1.9 km; Rmss = 0.95 seconds; Gp = 16° Version =
Event ID	us c000pdy4

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
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http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, March 27, 2014 3:50 PM
To: Dellinger, Philip; Johnson, Ken-E; Lawrence, Rob
Subject: FW: 2014-03-27 20:05:16 (M3.5) OKLAHOMA 35.9 -97.3 (63093)

Importance: High

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Thursday, March 27, 2014 3:49 PM
To: Dorsey, Nancy
Subject: 2014-03-27 20:05:16 (M3.5) OKLAHOMA 35.9 -97.3 (63093)

M3.5 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.5
Date-Time	27 Mar 2014 20:05:16 UTC 27 Mar 2014 15:05:17 near epicenter 27 Mar 2014 13:05:16 standard time in your timezone
Location	35.904N 97.290W
Depth	5 km
Distances	5 km (3 mi) SW of Langston, Oklahoma 12 km (7 mi) ENE of Guthrie, Oklahoma 31 km (19 mi) SW of Stillwater, Oklahoma 32 km (19 mi) NNE of Edmond, Oklahoma 52 km (32 mi) NNE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 67; Dmin = 19.4 km; Rmss = 0.66 seconds; Gp = 33° Version =
Event ID	us c000ntpw

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
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U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, March 20, 2014 12:07 PM
To: Dellinger, Philip; Lawrence, Rob; Graves, Brian; Johnson, Ken-E
Subject: FW: 2014-03-19 20:15:32 (M3.7) OKLAHOMA 36.0 -96.9 (63093)

Importance: High

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Wednesday, March 19, 2014 3:39 PM
To: Dorsey, Nancy
Subject: 2014-03-19 20:15:32 (M3.7) OKLAHOMA 36.0 -96.9 (63093)

M3.7 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.7
Date-Time	19 Mar 2014 20:15:32 UTC 19 Mar 2014 15:15:32 near epicenter 19 Mar 2014 13:15:32 standard time in your timezone
Location	35.965N 96.921W
Depth	5 km
Distances	10 km (6 mi) E of Perkins, Oklahoma 20 km (12 mi) SE of Stillwater, Oklahoma 46 km (28 mi) ENE of Guthrie, Oklahoma 60 km (37 mi) NNE of Choctaw, Oklahoma 77 km (47 mi) NE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 6.2 km
Parameters	Nph = 97; Dmin = 42.5 km; Rmss = 0.62 seconds; Gp = 20° Version =
Event ID	us c000nhcy

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, March 17, 2014 8:21 AM
To: Dellinger, Philip
Cc: Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Subject: slew of OK and KS Earthquakes
Attachments: OK_3_11_17_2014.JPG

The Kansas 4.0 was downgraded to a 3.7.

Orange is within last 24 hours, yellow within the last 7 days.

http://earthquake.usgs.gov/earthquakes/map/#%7B%22feed%22%3A%227day_all%22%2C%22search%22%3Anull%2C%22sort%22%3A%22newest%22%2C%22basemap%22%3A%22grayscale%22%2C%22autoUpdate%22%3Atrue%2C%22restrictListToMap%22%3Atrue%2C%22timeZone%22%3A%22local%22%2C%22mapposition%22%3A%5B%5B35.47856499535729%2C-98.865966796875%5D%2C%5B37.232515211349174%2C-95.75408935546875%5D%5D%2C%22overlays%22%3A%7B%22plates%22%3Atrue%7D%2C%22viewModes%22%3A%7B%22map%22%3Atrue%2C%22list%22%3Afalse%2C%22settings%22%3Afalse%2C%22help%22%3Afalse%7D%7D

Nancy S. Dorsey
Environmental Scientist
Oklahoma Class II Program Manager
WQ-SG EPA Region 6
1445 Ross Ave. #1200
Dallas, TX 75202-2733
214-665-2294
FAX 214-665-2191

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, March 11, 2014 8:28 AM
To: Dellinger, Philip; Johnson, Ken-E; Lawrence, Rob; Graves, Brian
Cc: Dwyer, Stacey
Subject: FW: 2014-03-11 12:55:27 (M3.7) OKLAHOMA 35.9 -97.3 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Tuesday, March 11, 2014 8:10 AM
To: Dorsey, Nancy
Subject: 2014-03-11 12:55:27 (M3.7) OKLAHOMA 35.9 -97.3 (63093)

M3.7 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.7
Date-Time	11 Mar 2014 12:55:27 UTC 11 Mar 2014 07:55:28 near epicenter 11 Mar 2014 05:55:27 standard time in your timezone
Location	35.897N 97.270W
Depth	5 km
Distances	5 km (3 mi) SSW of Langston, Oklahoma 14 km (8 mi) E of Guthrie, Oklahoma 30 km (18 mi) SW of Stillwater, Oklahoma 32 km (19 mi) NE of Edmond, Oklahoma 52 km (32 mi) NNE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 73; Dmin = 20.4 km; Rmss = 0.58 seconds; Gp = 29° Version =
Event ID	us c000n7mi

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
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U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, March 10, 2014 9:46 AM
To: Dellinger, Philip
Subject: FW: 2014-03-10 14:11:20 (M3.4) OKLAHOMA 36.1 -96.9 (63093) - hot off the press

Importance: High

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Monday, March 10, 2014 9:28 AM
To: Dorsey, Nancy
Subject: 2014-03-10 14:11:20 (M3.4) OKLAHOMA 36.1 -96.9 (63093)

M3.4 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.4
Date-Time	10 Mar 2014 14:11:20 UTC 10 Mar 2014 09:11:21 near epicenter 10 Mar 2014 07:11:20 standard time in your timezone
Location	36.113N 96.917W
Depth	5 km
Distances	12 km (7 mi) E of Stillwater, Oklahoma 52 km (32 mi) ENE of Guthrie, Oklahoma 67 km (41 mi) SSE of Ponca City, Oklahoma 71 km (44 mi) NE of Edmond, Oklahoma 89 km (55 mi) NE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 30; Dmin = 55.8 km; Rmss = 0.50 seconds; Gp = 104° Version =
Event ID	us c000n6d7

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, March 05, 2014 8:42 AM
To: Dellinger, Philip; Dwyer, Stacey; Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Subject: FW: 2014-03-05 14:17:06 (M3.9) OKLAHOMA 35.6 -97.4 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Wednesday, March 05, 2014 8:40 AM
To: Dorsey, Nancy
Subject: 2014-03-05 14:17:06 (M3.9) OKLAHOMA 35.6 -97.4 (63093)

M3.9 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.9
Date-Time	5 Mar 2014 14:17:06 UTC 5 Mar 2014 08:17:06 near epicenter 5 Mar 2014 07:17:06 standard time in your timezone
Location	35.638N 97.379W
Depth	5 km
Distances	9 km (5 mi) E of Edmond, Oklahoma 18 km (11 mi) NNW of Choctaw, Oklahoma 20 km (12 mi) N of Midwest City, Oklahoma 22 km (13 mi) NNE of Oklahoma City, Oklahoma 22 km (13 mi) NNE of Del City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 37; Dmin = 7.6 km; Rmss = 0.48 seconds; Gp = 50° Version =
Event ID	us b000n1im

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, March 05, 2014 8:10 AM
To: Dellinger, Philip; Johnson, Ken-E; Lawrence, Rob
Cc: Graves, Brian; Dwyer, Stacey
Subject: five earthquakes near Stillwater and Chandler Oklahoma
Attachments: 2014-03-05 02:02:57 (M2.1) OKLAHOMA 36.2 -97.0 (63093); 2014-03-05 01:53:01 (M2.4) OKLAHOMA 36.2 -97.0 (63093); 2014-03-04 17:11:30 (M2.2) OKLAHOMA 36.1 -96.9 (63093); 2014-03-04 17:44:10 (M2.9) OKLAHOMA 35.8 -97.0 (63093); 2014-03-04 00:22:10 (M2.3) OKLAHOMA 36.2 -97.0 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, February 27, 2014 8:01 AM
To: Dwyer, Stacey; Dellinger, Philip; Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Cc: Bates, William; Bierschenk, Arnold; Hurlbut, Bill
Subject: 3.7 EQ in OK
Attachments: 2014-02-27 00:19:09 (M3.3) OKLAHOMA 36.5 -97.1 (63093); 2014-02-27 10:14:02 (M3.7) OKLAHOMA 36.5 -97.1 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, February 26, 2014 2:23 PM
To: Dellinger, Philip; Johnson, Ken-E; Lawrence, Rob; Graves, Brian
Cc: Dwyer, Stacey
Subject: FW: 2014-02-26 19:30:33 (M3.4) OKLAHOMA 36.6 -97.7 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Wednesday, February 26, 2014 1:54 PM
To: Dorsey, Nancy
Subject: 2014-02-26 19:30:33 (M3.4) OKLAHOMA 36.6 -97.7 (63093)

M3.4 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.4
Date-Time	26 Feb 2014 19:30:33 UTC 26 Feb 2014 13:30:34 near epicenter 26 Feb 2014 12:30:33 standard time in your timezone
Location	36.626N 97.727W
Depth	5 km
Distances	20 km (12 mi) S of Medford, Oklahoma 28 km (17 mi) NNE of Enid, Oklahoma 58 km (35 mi) W of Ponca City, Oklahoma 78 km (48 mi) SW of Arkansas City, Kansas 129 km (79 mi) N of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 8.0 km
Parameters	Nph = 34; Dmin = 26.9 km; Rmss = 0.49 seconds; Gp = 85° Version =
Event ID	us c000mylm

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, February 19, 2014 12:26 PM
To: Dellinger, Philip; Graves, Brian; Johnson, Ken-E; Lawrence, Rob
Cc: Dwyer, Stacey
Subject: FW: 2014-02-19 16:44:57 (M3.2) OKLAHOMA 35.8 -97.5 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Wednesday, February 19, 2014 11:21 AM
To: Dorsey, Nancy
Subject: 2014-02-19 16:44:57 (M3.2) OKLAHOMA 35.8 -97.5 (63093)

M3.2 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.2
Date-Time	19 Feb 2014 16:44:57 UTC 19 Feb 2014 10:44:58 near epicenter 19 Feb 2014 09:44:57 standard time in your timezone
Location	35.763N 97.452W
Depth	6 km
Distances	12 km (7 mi) N of Edmond, Oklahoma 13 km (8 mi) S of Guthrie, Oklahoma 30 km (18 mi) NNE of Warr Acres, Oklahoma 31 km (19 mi) NNE of Bethany, Oklahoma 33 km (20 mi) N of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 7.3 km
Parameters	Nph = 33; Dmin = 4.1 km; Rmss = 1.13 seconds; Gp = 74° Version =
Event ID	us c000mtjk

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, February 19, 2014 7:55 AM
To: Dellinger, Philip; Johnson, Ken-E; Graves, Brian; Lawrence, Rob; Dwyer, Stacey
Subject: 10 more earthquakes near Guthrie, Edmond 2.1-3.0
Attachments: 2014-02-19 03:04:56 (M3.0) OKLAHOMA 36.1 -97.4 (63093); 2014-02-18 02:44:10 (M2.7) OKLAHOMA 35.8 -97.5 (63093); 2014-02-16 08:39:56 (M2.6) OKLAHOMA 35.8 -97.5 (63093); 2014-02-16 09:45:46 (M2.1) OKLAHOMA 35.8 -97.5 (63093); 2014-02-16 11:20:54 (M2.6) OKLAHOMA 35.8 -97.5 (63093); 2014-02-16 23:06:56 (M2.1) OKLAHOMA 35.8 -97.5 (63093); 2014-02-18 03:11:19 (M2.6) OKLAHOMA 35.8 -97.5 (63093); 2014-02-18 03:59:08 (M2.6) OKLAHOMA 35.8 -97.5 (63093); 2014-02-18 17:19:16 (M2.9) OKLAHOMA 35.8 -97.4 (63093); 2014-02-18 23:51:20 (M2.4) OKLAHOMA 35.7 -97.4 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, February 19, 2014 7:56 AM
To: Dellinger, Philip; Johnson, Ken-E; Graves, Brian; Lawrence, Rob; Dwyer, Stacey
Subject: FW: 2014-02-17 07:40:49 (M2.5) OKLAHOMA 35.8 -97.5 (63093) - eleven

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Wednesday, February 19, 2014 2:05 AM
To: Dorsey, Nancy
Subject: 2014-02-17 07:40:49 (M2.5) OKLAHOMA 35.8 -97.5 (63093)

M2.5 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	2.5
Date-Time	17 Feb 2014 07:40:49 UTC 17 Feb 2014 01:40:50 near epicenter 17 Feb 2014 00:40:49 standard time in your timezone
Location	35.772N 97.496W
Depth	5 km
Distances	13 km (8 mi) N of Edmond, Oklahoma 13 km (8 mi) SSW of Guthrie, Oklahoma 29 km (17 mi) NNE of Warr Acres, Oklahoma 30 km (18 mi) NNE of Bethany, Oklahoma 33 km (20 mi) N of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 20; Dmin = 4.9 km; Rmss = 0.63 seconds; Gp = 81° Version =
Event ID	us c000mt9x

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, February 18, 2014 1:58 PM
To: Dellinger, Philip; Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Cc: Dwyer, Stacey
Subject: three more near Guthrie
Attachments: 2014-02-18 14:22:01 (M2.7) OKLAHOMA 36.7 -97.7 (63093); 2014-02-17 14:37:30 (M2.7) OKLAHOMA 35.8 -97.5 (63093); 2014-02-18 15:17:18 (M2.8) OKLAHOMA 35.8 -97.5 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, February 18, 2014 1:07 PM
To: Ash, Christine
Subject: FW: Oklahoma news story on quake flurry this weekend.

Hi Chris,

The bottom link has a video by the seismologist with the Oklahoma Geologic Survey, that may help answer your RA's concerns.

Nancy

From: Dorsey, Nancy
Sent: Tuesday, February 18, 2014 8:09 AM
To: Dellinger, Philip; R6 6WQ-SG; Dwyer, Stacey
Subject: RE: Oklahoma news story on quake flurry this weekend.

And 4 this AM (Tuesday)

http://www.koco.com/news/oklahomanews/okc/at-least-3-earthquakes-rattle-central-oklahoma-tuesday-morning/24535828#mid=18402726

From: Dellinger, Philip
Sent: Tuesday, February 18, 2014 7:51 AM
To: R6 6WQ-SG; Dwyer, Stacey
Subject: Oklahoma news story on quake flurry this weekend.

http://www.koco.com/news/oklahomanews/around-oklahoma/why-are-oklahoma-earthquakes-so-loud-frequent/24511840

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, February 18, 2014 8:09 AM
To: Dellinger, Philip; R6 6WQ-SG; Dwyer, Stacey
Subject: RE: Oklahoma news story on quake flurry this weekend.

And 4 this AM (Tuesday)

http://www.koco.com/news/oklahomanews/okc/at-least-3-earthquakes-rattle-central-oklahoma-tuesday-morning/24535828#mid=18402726

From: Dellinger, Philip
Sent: Tuesday, February 18, 2014 7:51 AM
To: R6 6WQ-SG; Dwyer, Stacey
Subject: Oklahoma news story on quake flurry this weekend.

http://www.koco.com/news/oklahomanews/around-oklahoma/why-are-oklahoma-earthquakes-so-loud-frequent/24511840

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, February 10, 2014 11:12 AM
To: Bates, William
Subject: FW: Oklahoma 4.4 and damage reports plus
Attachments: 2014-02-09 04:55:14 (M2.8) OKLAHOMA 35.9 -97.3 (63093); 2014-02-09 02:16:01 (M4.4) OKLAHOMA 35.9 -97.3 (63093)

From: Dorsey, Nancy
Sent: Monday, February 10, 2014 9:22 AM
To: Dellinger, Philip; Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Cc: Dwyer, Stacey
Subject: Oklahoma 4.4 and damage reports plus

http://www.upi.com/Top_News/US/2014/02/10/Earthquake-damages-Logan-County-jail-in-Oklahoma/UPI-94801392016430/

http://www.kake.com/home/headlines/Earthquake-rattles-central-Oklahoma-244618571.html

Last seven days of Oklahoma earthquakes: http://www.okgeosurvey1.gov/pages/earthquakes/recent-earthquakes.php

Very interesting earthquake frequency charts (and pictures)**: http://eqcharts.com/**

Note the very large increase of earthquakes reported in Spain. An interesting table also check out the Magnitude 5 worldwide, though the total worldwide during that time significantly dropped. Hum!?

Locations Showing Increases in Earthquakes

Alabama
Alaska
Arkansas
British Columbia
Canada
Colorado
Dominican Republic
Fort St. John, B.C.
Georgia
Greece
Italy
Hawaii

Illinois
Maine
Mexico
Missouri
Montana

New York State
North Carolina
Northern California
Ohio
Oklahoma
Old Faithful Geyser
Puerto Rico

South Carolina
Southern Ontario
Spain
Tennessee
Texas
Turkey
Utah
United States (Continental)
Vancouver Island, B.C.
Virgin Islands

Dorsey, Nancy

From:	Dorsey, Nancy
Sent:	Monday, February 10, 2014 9:22 AM
To:	Dellinger, Philip; Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Cc:	Dwyer, Stacey
Subject:	Oklahoma 4.4 and damage reports plus
Attachments:	2014-02-09 04:55:14 (M2.8) OKLAHOMA 35.9 -97.3 (63093); 2014-02-09 02:16:01 (M4.4) OKLAHOMA 35.9 -97.3 (63093)

http://www.upi.com/Top_News/US/2014/02/10/Earthquake-damages-Logan-County-jail-in-Oklahoma/UPI-94801392016430/

http://www.kake.com/home/headlines/Earthquake-rattles-central-Oklahoma-244618571.html

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Locations Showing Increases in Earthquakes

Alabama
Alaska
Arkansas
British Columbia
Canada
Colorado
Dominican Republic
Fort St. John, B.C.
Georgia
Greece
Italy
Hawaii

Illinois
Maine
Mexico
Missouri
Montana
New York State
North Carolina
Northern California
Ohio
Oklahoma
Old Faithful Geyser
Puerto Rico

South Carolina
Southern Ontario
Spain
Tennessee
Texas
Turkey
Utah
United States (Continental)
Vancouver Island, B.C.
Virgin Islands

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, February 10, 2014 8:18 AM
To: Dellinger, Philip
Subject: Oklahoma 4.4
Attachments: 2014-02-09 04:55:14 (M2.8) OKLAHOMA 35.9 -97.3 (63093); 2014-02-09 02:16:01 (M4.4) OKLAHOMA 35.9 -97.3 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, January 30, 2014 8:05 AM
To: Dellinger, Philip; Lawrence, Rob; Johnson, Ken-E; Graves, Brian
Cc: Overbay, Michael; Dwyer, Stacey
Subject: FW: 2014-01-30 04:50:31 (M3.4) OKLAHOMA 35.9 -96.9 (63093)

Getting up there

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Wednesday, January 29, 2014 11:20 PM
To: Dorsey, Nancy
Subject: 2014-01-30 04:50:31 (M3.4) OKLAHOMA 35.9 -96.9 (63093)

M3.4 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.4
Date-Time	30 Jan 2014 04:50:31 UTC 29 Jan 2014 22:50:31 near epicenter 29 Jan 2014 21:50:31 standard time in your timezone
Location	35.922N 96.946W
Depth	9 km
Distances	9 km (5 mi) SE of Perkins, Oklahoma 23 km (14 mi) SSE of Stillwater, Oklahoma 43 km (26 mi) E of Guthrie, Oklahoma 55 km (34 mi) NNE of Choctaw, Oklahoma 72 km (44 mi) NE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 5.7 km
Parameters	Nph = 33; Dmin = 46.9 km; Rmss = 0.45 seconds; Gp = 107° Version =
Event ID	us c000mdes

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, January 23, 2014 7:59 AM
To: Dwyer, Stacey; Dellinger, Philip; Johnson, Ken-E
Cc: Overbay, Michael; Graves, Brian; Lawrence, Rob
Subject: 3 EQ in Trinidad CO, 2 in Stillwater, OK
Attachments: 2014-01-22 18:40:37 (M3.1) COLORADO 37.3 -104.6 (63093); 2014-01-22 18:45:04 (M3.7) COLORADO 37.2 -104.6 (63093); 2014-01-22 06:50:14 (M2.3) OKLAHOMA 36.1 -97.0 (63093); 2014-01-22 08:19:27 (M2.6) COLORADO 37.2 -104.4 (63093); 2014-01-22 17:28:46 (M2.7) OKLAHOMA 36.1 -97.0 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, January 21, 2014 10:39 AM
To: 'Lori Wrotenbery'; 'Charles Lord'; 'Tim Baker'
Subject: FW: Recent USGS Publications, - assigning blame for Wilzetta earthquake

First article, scroll down to photo of tumbled bricks. (I have not read the whole article yet, so there may be other statements of interest.)

From: Turner, Philip
Sent: Tuesday, January 21, 2014 10:15 AM
Subject: FW: Recent USGS Publications, Information, and Products that may be of interest to Texas - 20140120

From: owner-usgs-texas-info@igsrsparc2.er.usgs.gov [mailto:owner-usgs-texas-info@igsrsparc2.er.usgs.gov] **On Behalf Of** Fahlquist, Lynne
Sent: Tuesday, January 21, 2014 8:38 AM
To: usgs-texas-info@igsrsparc2.er.usgs.gov
Subject: Recent USGS Publications, Information, and Products that may be of interest to Texas - 20140120

Information

Man-made Earthquakes Update
http://www.usgs.gov/blogs/features/usgs_top_story/man-made-earthquakes/?from=title

USGS Science Pop Quiz
http://www.usgs.gov/blogs/features/usgs_science_pick/usgs-science-pop-quiz/?from=sp_title

Causes of Toxic Golden Algal Blooms Determined
http://www.usgs.gov/newsroom/article.asp?ID=3788

What Are Future Climate Predictions for Precipitation and Temperature for Your County?
http://www.usgs.gov/newsroom/article.asp?ID=3745

Thin Skin Beneath Streams Can Power Large Improvements in Water Quality
http://www.usgs.gov/newsroom/article.asp?ID=3748

New USGS Data Portal Provides Access to More Than a Century of Sediment Data
http://www.usgs.gov/newsroom/article.asp?ID=3779

Fact Sheet

Musgrove, M., and Crow, C.L., 2013, Origin and characteristics of discharge at San Marcos Springs, south-central Texas: U.S. Geological Survey Fact Sheet 2013–3080, 6 p.
http://dx.doi.org/10.3133/fs20133080

Faundeen, J.L., Kelly, F.P., Holm, T.M., and Nolt, J.E., 2013, National Satellite Land Remote Sensing Data Archive: U.S. Geological Survey Fact Sheet 2013-3100, 2 p.
http://dx.doi.org/10.3133/fs20133100

Scientific Investigations Report

Opsahl, S.P., and Lambert, R.B., 2013, Detections, concentrations, and distributional patterns of compounds of emerging concern in the San Antonio River Basin, Texas, 2011–12: U.S. Geological Survey Scientific Investigations Report 2013–5200, 44 p.
http://dx.doi.org/10.3133/sir20135200

Osborn, N.I., Smith, S.J., and Seger, C.H., 2013, Hydrogeology, distribution, and volume of saline groundwater in the southern midcontinent and adjacent areas of the United States: U.S. Geological Survey Scientific Investigations Report 2013–5017, 58 p.
http://dx.doi.org/10.3133/sir20135017

Wehmeyer, L.L., Winters, K.E., and Ockerman, D.J., 2013, A preliminary assessment of streamflow gains and losses for selected stream reaches in the lower Guadalupe River Basin, Texas, 2010–12: U.S. Geological Survey Scientific Investigations Report 2013–5209, 30 p.
http://dx.doi.org/10.3133/20135209

Open-File Report

Faundeen, J.L., Burley, T.E., Carlino, J.A., Govoni, D.L., Henkel, H.S., Holl, S.L., Hutchison, V.B., Martín, Elizabeth, Montgomery, E.T., Ladino, C.C., Tessler, Steven, and Zolly, L.S., 2013, The United States Geological Survey Science Data Lifecycle Model: U.S. Geological Survey Open-File Report 2013–1265, 4 p.
http://dx.doi.org/10.3133/ofr20131265

Ryberg, K.R., and Vecchia, A.V., 2013, seawaveQ—An R package providing a model and utilities for analyzing trends in chemical concentrations in streams with a seasonal wave (seawave) and adjustment for streamflow (Q) and other ancillary variables: U.S. Geological Survey Open-File Report 2013–1255, 13 p., with 3 appendixes.
http://dx.doi.org/10.3133/ofr20131255

Miller, H.M., Richardson, Leslie, Koontz, S.R., Loomis, John, and Koontz, Lynne, 2013, Users, uses, and value of Landsat satellite imagery—Results from the 2012 survey of users: U.S. Geological Survey Open-File Report 2013–1269, 51 p.
http://dx.doi.org/10.3133/ofr/20131269

Data Series

Lee, C.J., and Glysson, G.D., 2013, Compilation, quality control, analysis, and summary of discrete suspended-sediment and ancillary data in the United States, 1901–2010: U.S. Geological Survey Data Series 776, 35 p.
http://dx.doi.org/10.3133/ds776

Techniques and Methods

Banta, E.R., and Ahlfeld, D.P., 2013, GWM–VI—Groundwater management with parallel processing for multiple MODFLOW versions: U.S. Geological Survey Techniques and Methods, book 6, chap. A48, 33 p.
http://dx.doi.org/10.3133/tm6a48

Fitzpatrick, J.J., 2013, Digital-image processing and image analysis of glacier ice: U.S. Geological Survey Techniques and Methods, book 7, chap. D1, 21 p.
http://dx.doi.org/10.3133/tm7D1

Journal Article or Other

Asquith, W.H., 2014, Parameter estimation for the 4-parameter asymmetric exponential power distribution by the method of L-moments using R: Computational Statistics & Data Analysis, v. 71, pp. 955–970.
http://dx.doi.org/10.1016/j.csda.2012.12.013

Dhakal, N., Fang, X., Asquith, W.H., Cleveland, T.G., Thompson, D.B., 2013, Rate-based estimation of the rational runoff coefficients for selected watersheds in Texas: ASCE Journal of Hydrologic Engineering, v. 18, no. 12, pp. 1571-1580.

http://dx.doi.org/10.1061/(ASCE)HE.1943-5584.0000753

Gregory, J. M., White, N. J., Church, J. A., Bierkens, M. F. P., Box, J. E., Van den Broeke, M. R., Cogley, J. G., Fettweis, X., Hanna, E., Huybrechts, P., Konikow, L. F., Leclercq, P. W., Marzeion, B., Oerlemans, J., Tamisiea, M. E., Wada, Y., Wake, L. M. and Van de Wal, R. S. W., 2013, Twentieth-century global-mean sea-level rise--Is the whole greater than the sum of the parts?: Journal of Climate, v. 26, p. 4476-4499, DOI: 10.1175/JCLI-D-12-00319.1.

Long, A.J. and Mahler, B.J., 2013, Prediction, time variance, and classification of hydraulic response to recharge in two karst aquifers: Hydrology and Earth System Sciences, v. 17, pp. 281-294. http://www.hydrol-earth-syst-sci.net/17/281/2013/hess-17-281-2013.html

Mahler, B.J. and Bourgeais, R., 2013, Dissolved oxygen fluctuations in karst spring flow and implications for endemic species: Barton Springs, Edwards aquifer, Texas, USA: Journal of Hydrology, v. 505, pp. 291-298. http://dx.doi.org/10.1016/j.jhydrol.2013.10.004

Taylor, R.G., Scanlon, Bridget, Döll, Petra, Rodell, Matt, van Beek, Rens, Wada, Yoshihide, Longuevergne, Laurent, Leblanc, Marc, Famiglietti, J.S., Edmunds, W.M., Konikow, L.F., and others, 2013, Ground water and climate change: Nature Climate Change, v. 3, p. 322-329, DOI: 10.1038/NCLIMATE1744.

Cozzarelli, I.M., Mckelvie, J.R. and Baehr, A.L., 2014. 11.12 - Volatile Hydrocarbons and Fuel Oxygenates Treatise on Geochemistry (Second Edition). In: H.D. Holland and K.K. Turekian (Editors). Elsevier, Oxford, pp. 439-480.

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Lynne Fahlquist, Public Information Officer, P.G.
USGS Texas Water Science Center
1505 Ferguson Lane, Austin, TX 78754-4501
Ph. 512-927-3508 Cell 512-914-8669 Fax 512-927-3590
lfahlqst@usgs.gov
USGS Texas: http://tx.usgs.gov
Water Data: http://waterdata.usgs.gov/nwis
Publications: http://pubs.usgs.gov/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, January 21, 2014 10:36 AM
To: Dwyer, Stacey; Overbay, Michael; Dellinger, Philip; Lawrence, Rob; Johnson, Ken-E; Moore, Keara; Graves, Brian
Subject: FW: Recent USGS Publications, Information, and Products that may be of interest to Texas - 20140120

Suggest reading the first article!

From: Turner, Philip
Sent: Tuesday, January 21, 2014 10:15 AM
Subject: FW: Recent USGS Publications, Information, and Products that may be of interest to Texas - 20140120

From: owner-usgs-texas-info@igsrsparc2.er.usgs.gov [mailto:owner-usgs-texas-info@igsrsparc2.er.usgs.gov] **On Behalf Of** Fahlquist, Lynne
Sent: Tuesday, January 21, 2014 8:38 AM
To: usgs-texas-info@igsrsparc2.er.usgs.gov
Subject: Recent USGS Publications, Information, and Products that may be of interest to Texas - 20140120

Information

Man-made Earthquakes Update
http://www.usgs.gov/blogs/features/usgs_top_story/man-made-earthquakes/?from=title

USGS Science Pop Quiz
http://www.usgs.gov/blogs/features/usgs_science_pick/usgs-science-pop-quiz/?from=sp_title

Causes of Toxic Golden Algal Blooms Determined
http://www.usgs.gov/newsroom/article.asp?ID=3788

What Are Future Climate Predictions for Precipitation and Temperature for Your County?
http://www.usgs.gov/newsroom/article.asp?ID=3745

Thin Skin Beneath Streams Can Power Large Improvements in Water Quality
http://www.usgs.gov/newsroom/article.asp?ID=3748

New USGS Data Portal Provides Access to More Than a Century of Sediment Data
http://www.usgs.gov/newsroom/article.asp?ID=3779

Fact Sheet

Musgrove, M., and Crow, C.L., 2013, Origin and characteristics of discharge at San Marcos Springs, south-central Texas: U.S. Geological Survey Fact Sheet 2013–3080, 6 p.
http://dx.doi.org/10.3133/fs20133080

Faundeen, J.L., Kelly, F.P., Holm, T.M., and Nolt, J.E., 2013, National Satellite Land Remote Sensing Data Archive: U.S. Geological Survey Fact Sheet 2013-3100, 2 p.
http://dx.doi.org/10.3133/fs20133100

Scientific Investigations Report

Opsahl, S.P., and Lambert, R.B., 2013, Detections, concentrations, and distributional patterns of compounds of emerging concern in the San Antonio River Basin, Texas, 2011–12: U.S. Geological Survey Scientific Investigations Report 2013–5200, 44 p.
http://dx.doi.org/10.3133/sir20135200

Osborn, N.I., Smith, S.J., and Seger, C.H., 2013, Hydrogeology, distribution, and volume of saline groundwater in the southern midcontinent and adjacent areas of the United States: U.S. Geological Survey Scientific Investigations Report 2013–5017, 58 p.
http://dx.doi.org/10.3133/sir20135017

Wehmeyer, L.L., Winters, K.E., and Ockerman, D.J., 2013, A preliminary assessment of streamflow gains and losses for selected stream reaches in the lower Guadalupe River Basin, Texas, 2010–12: U.S. Geological Survey Scientific Investigations Report 2013–5209, 30 p.
http://dx.doi.org/10.3133/20135209

Open-File Report

Faundeen, J.L., Burley, T.E., Carlino, J.A., Govoni, D.L., Henkel, H.S., Holl, S.L., Hutchison, V.B., Martín, Elizabeth, Montgomery, E.T., Ladino, C.C., Tessler, Steven, and Zolly, L.S., 2013, The United States Geological Survey Science Data Lifecycle Model: U.S. Geological Survey Open-File Report 2013–1265, 4 p.
http://dx.doi.org/10.3133/ofr20131265

Ryberg, K.R., and Vecchia, A.V., 2013, seawaveQ—An R package providing a model and utilities for analyzing trends in chemical concentrations in streams with a seasonal wave (seawave) and adjustment for streamflow (Q) and other ancillary variables: U.S. Geological Survey Open-File Report 2013–1255, 13 p., with 3 appendixes.
http://dx.doi.org/10.3133/ofr20131255

Miller, H.M., Richardson, Leslie, Koontz, S.R., Loomis, John, and Koontz, Lynne, 2013, Users, uses, and value of Landsat satellite imagery—Results from the 2012 survey of users: U.S. Geological Survey Open-File Report 2013–1269, 51 p.
http://dx.doi.org/10.3133/ofr/20131269

Data Series

Lee, C.J., and Glysson, G.D., 2013, Compilation, quality control, analysis, and summary of discrete suspended-sediment and ancillary data in the United States, 1901–2010: U.S. Geological Survey Data Series 776, 35 p.
http://dx.doi.org/10.3133/ds776

Techniques and Methods

Banta, E.R., and Ahlfeld, D.P., 2013, GWM–VI—Groundwater management with parallel processing for multiple MODFLOW versions: U.S. Geological Survey Techniques and Methods, book 6, chap. A48, 33 p.
http://dx.doi.org/10.3133/tm6a48

Fitzpatrick, J.J., 2013, Digital-image processing and image analysis of glacier ice: U.S. Geological Survey Techniques and Methods, book 7, chap. D1, 21 p.
http://dx.doi.org/10.3133/tm7D1

Journal Article or Other

Asquith, W.H., 2014, Parameter estimation for the 4-parameter asymmetric exponential power distribution by the method of L-moments using R: Computational Statistics & Data Analysis, v. 71, pp. 955–970.
http://dx.doi.org/10.1016/j.csda.2012.12.013

Dhakal, N., Fang, X., Asquith, W.H., Cleveland, T.G., Thompson, D.B., 2013, Rate-based estimation of the rational runoff coefficients for selected watersheds in Texas: ASCE Journal of Hydrologic Engineering, v. 18, no. 12, pp. 1571-1580. http://dx.doi.org/10.1061/(ASCE)HE.1943-5584.0000753

Gregory, J. M., White, N. J., Church, J. A., Bierkens, M. F. P., Box, J. E., Van den Broeke, M. R., Cogley, J. G., Fettweis, X., Hanna, E., Huybrechts, P., Konikow, L. F., Leclercq, P. W., Marzeion, B., Oerlemans, J., Tamisiea, M. E., Wada, Y., Wake, L. M. and Van de Wal, R. S. W., 2013, Twentieth-century global-mean sea-level rise--Is the whole greater than the sum of the parts?: Journal of Climate, v. 26, p. 4476-4499, DOI: 10.1175/JCLI-D-12-00319.1.

Long, A.J. and Mahler, B.J., 2013, Prediction, time variance, and classification of hydraulic response to recharge in two karst aquifers: Hydrology and Earth System Sciences, v. 17, pp. 281-294. http://www.hydrol-earth-syst-sci.net/17/281/2013/hess-17-281-2013.html

Mahler, B.J. and Bourgeais, R., 2013, Dissolved oxygen fluctuations in karst spring flow and implications for endemic species: Barton Springs, Edwards aquifer, Texas, USA: Journal of Hydrology, v. 505, pp. 291-298. http://dx.doi.org/10.1016/j.jhydrol.2013.10.004

Taylor, R.G., Scanlon, Bridget, Döll, Petra, Rodell, Matt, van Beek, Rens, Wada, Yoshihide, Longuevergne, Laurent, Leblanc, Marc, Famiglietti, J.S., Edmunds, W.M., Konikow, L.F., and others, 2013, Ground water and climate change: Nature Climate Change, v. 3, p. 322-329, DOI: 10.1038/NCLIMATE1744.

Cozzarelli, I.M., Mckelvie, J.R. and Baehr, A.L., 2014. 11.12 - Volatile Hydrocarbons and Fuel Oxygenates Treatise on Geochemistry (Second Edition). In: H.D. Holland and K.K. Turekian (Editors). Elsevier, Oxford, pp. 439-480.

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If you have questions, please contact Lynne Fahlquist (contact info below).

--

Lynne Fahlquist, Public Information Officer, P.G.
USGS Texas Water Science Center
1505 Ferguson Lane, Austin, TX 78754-4501
Ph. 512-927-3508 Cell 512-914-8669 Fax 512-927-3590
lfahlqst@usgs.gov
USGS Texas: http://tx.usgs.gov
Water Data: http://waterdata.usgs.gov/nwis
Publications: http://pubs.usgs.gov/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, January 09, 2014 8:22 AM
To: Dwyer, Stacey; Dellinger, Philip; Overbay, Michael; Johnson, Ken-E; Lawrence, Rob
Subject: FW: 2014-01-09 03:26:53 (M3.5) OKLAHOMA 35.5 -96.8 (63093) Prague 3.5

For what little they say
http://newsok.com/magnitude-3.5-quake-reported-near-prague/article/3922018
http://www.newson6.com/story/24401640/35-magnitude-earthquake-shakes-near-prague

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From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Wednesday, January 08, 2014 9:40 PM
To: Dorsey, Nancy
Subject: 2014-01-09 03:26:53 (M3.5) OKLAHOMA 35.5 -96.8 (63093)

M3.5 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.5
Date-Time	9 Jan 2014 03:26:53 UTC 8 Jan 2014 21:26:53 near epicenter 8 Jan 2014 20:26:53 standard time in your timezone
Location	35.546N 96.760W
Depth	4 km
Distances	9 km (5 mi) NW of Prague, Oklahoma 28 km (17 mi) NNE of Shawnee, Oklahoma 46 km (28 mi) E of Choctaw, Oklahoma 58 km (35 mi) E of Midwest City, Oklahoma 69 km (42 mi) E of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 26; Dmin = 9.8 km; Rmss = 0.44 seconds; Gp = 110° Version =
Event ID	us c000lz7a

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey

http://earthquake.usgs.gov/regional/neic/

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https://sslearthquake.usgs.gov/ens/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, January 08, 2014 8:36 AM
To: Moore, Keara; Bates, William
Subject: RE: seismicity in EPA HF study

I heard about it around Christmas time.

From: Moore, Keara
Sent: Monday, January 06, 2014 8:44 AM
To: Dorsey, Nancy; Bates, William
Subject: seismicity in EPA HF study

Did you guys know about this?

http://www2.epa.gov/hfstudy/modeling-fault-reactivation-and-induced-seismicity-during-hydraulic-fracturing-shale-gas

Keara Moore
Underground Injection Control Program
Office of Ground Water and Drinking Water
U.S. Environmental Protection Agency
Ph: 202-564-3173

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, December 30, 2013 8:13 AM
To: Dwyer, Stacey; Dellinger, Philip; Johnson, Ken-E; Lawrence, Rob
Subject: FW: 2013-12-29 08:14:36 (M4.1) OKLAHOMA 35.9 -97.3 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Sunday, December 29, 2013 2:27 AM
To: Dorsey, Nancy
Subject: 2013-12-29 08:14:36 (M4.1) OKLAHOMA 35.9 -97.3 (63093)

M4.1 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	4.1
Date-Time	29 Dec 2013 08:14:36 UTC 29 Dec 2013 02:14:37 near epicenter 29 Dec 2013 01:14:36 standard time in your timezone
Location	35.896N 97.306W
Depth	5 km
Distances	7 km (4 mi) SW of Langston, Oklahoma 10 km (6 mi) E of Guthrie, Oklahoma 31 km (19 mi) NNE of Edmond, Oklahoma 33 km (20 mi) SW of Stillwater, Oklahoma 51 km (31 mi) NNE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 17; Dmin = 27.9 km; Rmss = 0.20 seconds; Gp = 123° Version =
Event ID	us c000ltkv

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, December 11, 2013 8:29 AM
To: Dellinger, Philip; Graves, Brian; Johnson, Ken-E; Lawrence, Rob
Cc: Dwyer, Stacey
Subject: OKC and Azle earthquakes
Attachments: 2013-12-10 15:39:49 (M2.7) NORTHERN TEXAS 32.9 -97.5 (63093); 2013-12-08 19:05:17 (M2.1) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.4 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, December 10, 2013 10:32 AM
To: McKenzie, Susie; Dellinger, Philip; Johnson, Ken-E; Lawrence, Rob
Cc: Dwyer, Stacey
Subject: another smallish Prague earthquake FW: 2013-12-08 16:08:15 (M2.6) OKLAHOMA 35.6 -96.8 (63093)

From: USGS ENS
Sent: Tuesday, December 10, 2013 10:16 AM
To: Dorsey, Nancy
Subject: 2013-12-08 16:08:15 (M2.6) OKLAHOMA 35.6 -96.8 (63093)

M2.6 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	2.6
Date-Time	8 Dec 2013 16:08:15 UTC 8 Dec 2013 10:08:16 near epicenter 8 Dec 2013 09:08:15 standard time in your timezone
Location	35.559N 96.754W
Depth	5 km
Distances	10 km (6 mi) NW of Prague, Oklahoma 30 km (18 mi) NNE of Shawnee, Oklahoma 47 km (29 mi) E of Choctaw, Oklahoma 59 km (36 mi) ENE of Midwest City, Oklahoma 69 km (42 mi) E of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 0; Dmin = ; Rmss = 0.48 seconds; Gp = Version =
Event ID	us c000lhef

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
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U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, December 02, 2013 8:49 AM
To: Dellinger, Philip; McKenzie, Susie; Johnson, Ken-E; Lawrence, Rob
Cc: Dwyer, Stacey
Subject: 8 shakes in Oklahoma Stillwater, Guthrie and Edmond areas
Attachments: 2013-12-02 07:21:52 (M2.5) OKLAHOMA 35.6 -97.4 (63093); 2013-12-02 07:10:54 (M2.9) OKLAHOMA 35.6 -97.4 (63093); 2013-11-30 21:13:39 (M2.9) OKLAHOMA 35.9 -97.3 (63093); 2013-11-29 18:23:44 (M2.8) OKLAHOMA 36.5 -97.9 (63093); 2013-11-29 00:41:04 (M2.3) OKLAHOMA 36.2 -97.1 (63093); 2013-11-28 23:06:33 (M2.6) OKLAHOMA 36.1 -97.0 (63093); 2013-11-28 12:59:30 (M2.2) OKLAHOMA 35.7 -97.5 (63093); 2013-11-28 10:22:57 (M2.4) OKLAHOMA 36.1 -97.0 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, November 22, 2013 9:01 AM
To: Dwyer, Stacey; Dellinger, Philip; McKenzie, Susie; Johnson, Ken-E; Overbay, Michael
Subject: FW: 2013-11-22 14:33:59 (M3.7) OKLAHOMA 36.2 -97.0 (63093)

From: USGS ENS
Sent: Friday, November 22, 2013 8:45 AM
To: Dorsey, Nancy
Subject: 2013-11-22 14:33:59 (M3.7) OKLAHOMA 36.2 -97.0 (63093)

M3.7 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.7
Date-Time	22 Nov 2013 14:33:59 UTC 22 Nov 2013 08:34:00 near epicenter 22 Nov 2013 07:33:59 standard time in your timezone
Location	36.169N 96.963W
Depth	5 km
Distances	10 km (6 mi) NE of Stillwater, Oklahoma 52 km (32 mi) NE of Guthrie, Oklahoma 60 km (37 mi) S of Ponca City, Oklahoma 73 km (45 mi) NE of Edmond, Oklahoma 92 km (57 mi) NNE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 1.8 km
Parameters	Nph = 35; Dmin = 68.5 km; Rmss = 0.73 seconds; Gp = 105° Version =
Event ID	us b000l4ak

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, November 22, 2013 7:24 AM
To: McKenzie, Susie; Dellinger, Philip; Johnson, Ken-E
Cc: Dwyer, Stacey
Subject: FW: 2013-11-22 05:35:17 (M2.1) OKLAHOMA 35.8 -97.4 (63093)

From: USGS ENS
Sent: Friday, November 22, 2013 3:16 AM
To: Dorsey, Nancy
Subject: 2013-11-22 05:35:17 (M2.1) OKLAHOMA 35.8 -97.4 (63093)

M2.1 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	2.1
Date-Time	22 Nov 2013 05:35:17 UTC 21 Nov 2013 23:35:17 near epicenter 21 Nov 2013 22:35:17 standard time in your timezone
Location	35.759N 97.363W
Depth	5 km
Distances	14 km (8 mi) SSE of Guthrie, Oklahoma 15 km (9 mi) NE of Edmond, Oklahoma 30 km (18 mi) NNW of Choctaw, Oklahoma 34 km (21 mi) N of Midwest City, Oklahoma 35 km (21 mi) NNE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 0.0 km; Vertical 2.0 km
Parameters	Nph = 10; Dmin = 12.2 km; Rmss = 0.38 seconds; Gp = 200° Version =
Event ID	us b000l469

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, November 14, 2013 10:23 AM
To: Charles Lord; Ron Dunkin; Lori Wrotenbery
Cc: McKenzie, Susie; Johnson, Ken-E; Lawrence, Rob; Dellinger, Philip; Graves, Brian; Dwyer, Stacey; Bechdol, Michael
Subject: NPR today Oklahomans Live With Shaking as Researchers Study Earthquake Swarm

I am sure you have already seen this, but just in case.

http://stateimpact.npr.org/oklahoma/2013/11/14/oklahomans-live-with-shaking-as-researchers-study-earthquake-swarm/

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, November 14, 2013 10:10 AM
To: 'Charles Lord'
Subject: FW: Oklahoma Geological Survey Poster

From: Morris, Abigail
Sent: Thursday, November 14, 2013 10:07 AM
To: Dorsey, Nancy
Subject: RE: Oklahoma Geological Survey Poster

EnergyWire just had it today, maybe they were leaking it? Let me know if there's anything else you need. It seems like there's lots of earthquakes in the area lately. Glad my childhood in southern California gave me plenty of preparation ☺.

Thanks-

Abby Morris Librarian I, Document Systems Incorporated, a contractor for the EPA
US EPA Region 6 Library
214-665-6424
morris.abigail@epa.gov

From: Dorsey, Nancy
Sent: Thursday, November 14, 2013 10:04 AM
To: Morris, Abigail
Subject: RE: Oklahoma Geological Survey Poster

Thanks. I have seen it, but understood it wasn't to be released yet. Obviously not correct. ☺

From: Morris, Abigail
Sent: Thursday, November 14, 2013 9:56 AM
To: Dorsey, Nancy
Subject: Oklahoma Geological Survey Poster

I'm not sure if you already saw this, but the Oklahoma Geological Survey released this poster about the Earthquake swarm going on there on November 12. I've attached it above.

Thanks-

Abby Morris Librarian I, Document Systems Incorporated, a contractor for the EPA
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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, November 14, 2013 10:03 AM
To: 'Charles Lord'
Subject: FW: Oklahoma Geological Survey Poster
Attachments: OK Geological Survey Earthquake Swarm Poster.pdf

So much for there not releasing the poster!

From: Morris, Abigail
Sent: Thursday, November 14, 2013 9:56 AM
To: Dorsey, Nancy
Subject: Oklahoma Geological Survey Poster

I'm not sure if you already saw this, but the Oklahoma Geological Survey released this poster about the Earthquake swarm going on there on November 12. I've attached it above.

Thanks-

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Mail Code: 6MD-OE
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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, November 12, 2013 8:07 AM
To: Dellinger, Philip; McKenzie, Susie; Graves, Brian; Lawrence, Rob; Johnson, Ken-E
Cc: Dwyer, Stacey; Frazier, Mike
Subject: 3 EQ in N TX 15 in OK over weekend
Attachments: 2013-11-09 03:34:07 (M2.4) NORTHERN TEXAS 32.9 -97.6 (63093); 2013-11-09 19:54:31 (M3.0) NORTHERN TEXAS 32.9 -97.7 (63093); 2013-11-11 08:30:54 (M2.8) NORTHERN TEXAS 33.0 -97.6 (63093)

Oklahoma quakes mostly near Edmond

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, November 08, 2013 7:56 AM
To: Dellinger, Philip; McKenzie, Susie; Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Cc: Dwyer, Stacey
Subject: EQ: 4 OKC 1 N TX
Attachments: 2013-11-08 06:29:40 (M2.7) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.4 (63093); 2013-11-08 06:03:17 (M2.5) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.4 (63093); 2013-11-07 22:50:15 (M2.7) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.5 (63093); 2013-11-08 05:50:05 (M3.2) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.4 (63093); 2013-11-08 04:32:57 (M2.9) NORTHERN TEXAS 33.0 -97.6 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Thursday, November 07, 2013 8:13 AM
To: Dellinger, Philip; McKenzie, Susie; Johnson, Ken-E; Lawrence, Rob; Graves, Brian
Subject: Urban OKC EQs
Attachments: 2013-11-05 06:13:07 (M2.5) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.5 (63093); 2013-11-04 21:35:38 (M2.0) OKLAHOMA CITY URBAN AREA, OKLAHOMA 35.6 -97.4 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, October 25, 2013 11:53 AM
To: Honker, William; Garcia, David
Subject: FW: Soraghan E&E 3-25-2013 --OKC increased seismicity expose
Attachments: Soraghan E&E 3-25-2013.docx

From: Dorsey, Nancy
Sent: Friday, October 25, 2013 11:48 AM
To: Dellinger, Philip; McKenzie, Susie; Lawrence, Rob; Johnson, Ken-E; Dwyer, Stacey
Cc: Gray, David; Moore, Keara
Subject: FW: Soraghan E&E 3-25-2013

The fuse for the E&E article

http://www.usgs.gov/newsroom/article.asp?ID=3710&from=rss_home

Dorsey, Nancy

From: Charles Lord <C.Lord@occemail.com>
Sent: Friday, October 25, 2013 10:11 AM
To: Dorsey, Nancy
Subject: Soraghan E&E 3-25-2013
Attachments: Soraghan E&E 3-25-2013.docx

You may have seen this.

Charles

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, October 23, 2013 3:10 PM
To: McKenzie, Susie; Lawrence, Rob; Dellinger, Philip; Johnson, Ken-E
Subject: Sky falling?

http://www.usgs.gov/newsroom/article.asp?ID=3680

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, September 23, 2013 8:08 AM
To: McKenzie, Susie; Dellinger, Philip; Graves, Brian; Lawrence, Rob; Johnson, Ken-E
Cc: Dwyer, Stacey
Subject: Shaking over weekend 3 OK 1 Trinidad area in CO
Attachments: 2013-09-20 02:14:59 (M2.9) COLORADO 37.0 -104.8 (63093); 2013-09-22 04:36:42 (M2.9) OKLAHOMA 36.0 -96.9 (63093); 2013-09-22 20:07:07 (M2.7) OKLAHOMA 35.5 -96.5 (63093); 2013-09-23 11:40:42 (M3.2) OKLAHOMA 34.0 -97.2 (63093)

Dorsey, Nancy

From: Lawrence, Rob
Sent: Friday, September 13, 2013 9:49 AM
To: McKenzie, Susie; Dorsey, Nancy; Dellinger, Philip
Subject: FW: presentation on induced seismicity

Frohlich's recent presentation

Rob Lawrence
Region 6
Policy Advisor - Energy Issues
214.665.6580

From: McFadden, Angela
Sent: Friday, September 13, 2013 9:47 AM
To: Platt, Steve; Overbay, Michael; Lawrence, Rob
Subject: presentation on induced seismicity

In case you don't have this already

From Sept 9-10 NAS workshop in WV

http://dels.nas.edu/resources/static-assets/besr/miscellaneous/ShaleGasPresentations/Frohlich.pdf

Angela McFadden

U.S. Environmental Protection Agency, Region III
Water Protection Division
1650 Arch Street (3WP00)
Philadelphia, PA 19103-2029

215-814-2324

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, August 05, 2013 10:21 AM
To: Charles Lord; 'Tim Baker'; 'Ron Dunkin'
Subject: FW: EARTHQUAKES: 'Do not operate' quake-linked disposal wells -- EPA draft report

You probably already saw this.

The link actually takes the reader to our draft document.

EARTHQUAKES: 'Do not operate' quake-linked disposal wells -- EPA draft report

Mike Soraghan, E&E reporter

Published: Monday, July 22, 2013

U.S. EPA officials say oil and gas wastewater injection wells that are causing earthquakes should stop operating if there's no way to stop the shaking.

But there is a variety of other options to consider first, according to a "decision model" outlined in a draft report obtained by *EnergyWire*. That includes scaling back how much well owners can inject, requiring more data collection or public education about "the complexities of injection-induced seismicity."

The 341-page document represents the main EPA response to concerns that drilling-related activities are causing earthquakes. It was provided as a result of a Freedom of Information Act appeal after agency officials declined to release it (*EnergyWire*, May 28).

The report is designed to offer state officials suggestions for dealing with man-made earthquakes, also known as "induced seismicity."

The draft specifically notes that federal law allows regulators to close down wells. And on Page 25, a diagram lays out the option when the other options haven't worked -- "Do not operate well."

Little or no further guidance is offered on the topic.

State oil and gas officials in Arkansas and Ohio have shut down wells linked to earthquakes. In Texas, a company shut wells that were causing quakes near the Dallas-Fort Worth airport.

In Oklahoma, state oil and gas officials are continuing to allow injection of drilling wastewater in areas where researchers have linked the wells to damaging earthquakes (*EnergyWire*, July 25, 2012).

The development of recommendations on drilling-related quakes has stalled for unknown reasons. The report is a year and a half late, and EPA officials have no timetable for completing it or releasing it.

The report is an "internal document in preliminary draft form" that was distributed in November 2012 to technical experts who'd contributed to the report. The agency is now weighing their comments.

"EPA plans to submit the draft report for independent external peer review," James McDonald, assistant regional administrator for management in the Dallas-based Region 6 office, wrote in a July 9 letter accompanying the report. The letter doesn't mention completing the report or releasing it.

Oil and gas regulation can be a touchy subject at EPA. The agency has been under intense criticism from the oil and gas industry and congressional Republicans as it weighs its role in the nation's shale boom. Environmentalists have criticized the agency for pulling back from three major water contamination cases in Pennsylvania, Texas and Wyoming.

Scientists have known for decades that underground injection of fluid can lubricate faults and unleash earthquakes. Some seismologists now think the boom in shale drilling in the United States -- and the wastewater it produces -- might be causing a sharp increase in the number of earthquakes in the middle of the country.

Producing oil and gas from shale formations such as those found in Arkansas, Pennsylvania and Ohio requires the use of millions of gallons of water for hydraulic fracturing. In turn, that creates millions of gallons of salty, toxic wastewater. Drillers must figure out how to dispose of it. Some reuse part of it in the next "frack job," but they often inject it back underground in one of the nation's 40,000 deep injection wells.

Researchers have linked such deep injection wells to earthquakes in Oklahoma, Arkansas, Texas, Ohio and Colorado. More "earth-friendly" procedures, such as geothermal energy production and carbon sequestration, can also set the earth rumbling.

Oil and gas production is regulated almost entirely by states. But a federal law, the Safe Drinking Water Act, governs underground injection of drilling wastewater. EPA regulates disposal directly in a few states, such as Pennsylvania, but in most it has handed day-to-day regulation to state agencies.

The Safe Drinking Water Act doesn't make it illegal to cause an earthquake. Instead, EPA seeks to prevent earthquakes because they might harm the underground sources of drinking water the act does protect.

EPA's examination of man-made earthquakes was undertaken by a technical working group of EPA and state officials in 2011. It has been shepherded by the staff of the agency's South Central Region, also called Region 6. The region has been caught in some of the fiercest debates about federal versus state regulation.

Leaders of the effort stressed that the group was not seeking to make new policies or regulations. Instead, it was to develop recommendations for state officials for dealing with injection wells linked to earthquakes.

The group partnered with state regulators and seismologists at the U.S. Geological Survey and researched in-depth case studies on quakes in Arkansas, Texas and West Virginia.

The goal of the project has changed over time. When the study began, the goal was "avoiding" significant earthquakes, according to documents included in the report. Now the goal -- reflected in the report's title -- is "minimizing and managing potential impacts."

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, July 12, 2013 2:00 PM
To: 'Charles Lord'
Subject: FW: Science articles on Injection-Induced Earthquakes
Attachments: Injection-Induced Earthquakes.pdf; Enhanced Remote Earthquake Triggering at Fluid-Injection Sites in Midwestern States.pdf; Anthropogenic Seismicity Rates and Operational Parameters at the Salton Sea Geothermal Field.pdf; Some Earthquakes Warn When They are About to Strike.pdf

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From: Dorsey, Nancy
Sent: Friday, July 12, 2013 12:02 PM
To: Dwyer, Stacey; Moore, Keara; Graves, Brian; Lawrence, Rob; Johnson, Ken-E
Cc: Gray, David
Subject: FW: Science articles on Injection-Induced Earthquakes

Our wonderfully proactive librarian took the initiative and pulled the original Science articles, that the various other reporters are … not doing such a great job of paraphrasing.

From: Morris, Abigail
Sent: Friday, July 12, 2013 11:56 AM
To: Dorsey, Nancy
Cc: McKenzie, Susie
Subject: Sceince articles on Injection-Induced Earthquakes

The July 12th issue of Science Magazine has a few articles about injection wells and seismicity/seismic activities. I've attached the ones I found above.

Here's a link to a Desktop Library search that will bring up Science Magazine (it's the second option):
http://fn4qj3vk6a.search.serialssolutions.com/?V=1.0&N=100&tab=JOURNALS&L=FN4QJ3VK6A&S=A_T_M&C=Science
From there you should be able to see the full-text articles for non-commercial use.

Please let me know if you need any additional information or assistance.

Thanks-

Abby Morris Librarian I, Document Systems Incorporated, a contractor for the EPA
US EPA Region 6 Library
Mail Code: 6MD-OE
1445 Ross Avenue Suite 1200
Dallas, Texas 75202-2733

morris.abigail@epa.gov
Region6.library@epa.gov

For current environmental and regulatory news and events that impact Region 6:
http://region6.epa.gov/intranet/6md/info/r6lib/new_resources.cfm

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http://www.surveymonkey.com/s/epalibsurvey
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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, July 09, 2013 11:40 AM
To: Morris, Abigail
Subject: Article please

Holland, A.A., 2013. Earthquakes Triggered by Hydraulic Fracturing in South-Central Oklahoma, Bull. Seismol. Soc. Am., 103, 1784-1792, doi:10.1785/0120120109.

http://bssa.geoscienceworld.org/content/103/3/1784.full.pdf+html

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Tuesday, June 25, 2013 8:07 AM
To: Dellinger, Philip; McKenzie, Susie; Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Subject: FW: 2013-06-24 23:07:48 (M3.0) OKLAHOMA 34.5 -96.4 (63093) nr Ada

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Monday, June 24, 2013 6:25 PM
To: Dorsey, Nancy
Subject: 2013-06-24 23:07:48 (M3.0) OKLAHOMA 34.5 -96.4 (63093)

M3.0 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.0
Date-Time	24 Jun 2013 23:07:48 UTC 24 Jun 2013 18:07:49 near epicenter 24 Jun 2013 16:07:48 standard time in your timezone
Location	34.517N 96.369W
Depth	14 km
Distances	13 km (8 mi) W of Coalgate, Oklahoma 40 km (24 mi) SE of Ada, Oklahoma 57 km (35 mi) N of Durant, Oklahoma 71 km (44 mi) SW of McAlester, Oklahoma 148 km (91 mi) SE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 10.8 km; Vertical 11.6 km
Parameters	Nph = 35; Dmin = 92.6 km; Rmss = 1.24 seconds; Gp = 102° Version = 7
Event ID	us c000hzgp

For updates, maps, and technical information, see: Event Page or USGS Earthquake Hazards Program
National Earthquake Information Center
U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, June 17, 2013 8:12 AM
To: Dellinger, Philip; Graves, Brian; McKenzie, Susie; Johnson, Ken-E; Lawrence, Rob; Overbay, Michael
Subject: Oklahoma rocking and rolling
Attachments: 2013-06-17 06:39:01 (M3.1) OKLAHOMA 35.5 -97.1 (63093); 2013-06-16 18:06:17 (M3.2) OKLAHOMA 35.6 -97.2 (63093); 2013-06-16 11:49:51 (M2.8) OKLAHOMA 35.4 -96.5 (63093); 2013-06-16 08:08:37 (M2.7) OKLAHOMA 35.5 -97.3 (63093)

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, June 10, 2013 9:04 AM
To: Dellinger, Philip; McKenzie, Susie; Johnson, Ken-E; Graves, Brian
Subject: FW: 2013-06-09 07:12:31 (M3.4) OKLAHOMA 35.6 -97.2 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Sunday, June 09, 2013 2:25 AM
To: Dorsey, Nancy
Subject: 2013-06-09 07:12:31 (M3.4) OKLAHOMA 35.6 -97.2 (63093)

M3.4 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.4
Date-Time	9 Jun 2013 07:12:31 UTC 9 Jun 2013 02:12:32 near epicenter 9 Jun 2013 00:12:31 standard time in your timezone
Location	35.590N 97.201W
Depth	5 km
Distances	7 km (4 mi) S of Luther, Oklahoma 11 km (6 mi) NNE of Choctaw, Oklahoma 23 km (14 mi) NE of Midwest City, Oklahoma 26 km (16 mi) ESE of Edmond, Oklahoma 31 km (19 mi) ENE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 21.6 km; Vertical 2.9 km
Parameters	Nph = 12; Dmin = 8.1 km; Rmss = 0.48 seconds; Gp = 114° Version = 4
Event ID	us c000hjnd

For updates, maps, and technical information, see:
Event Page
or
USGS Earthquake Hazards Program

National Earthquake Information Center
U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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https://sslearthquake.usgs.gov/ens/

To unsubscribe, send a one-line reply to this message with:

STOP dorsey.nancy@epa.gov

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, April 29, 2013 2:13 PM
To: 'Charles Lord'
Subject: Wilzetta thesis
Attachments: Thesis_KincaidWay.pdf

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Monday, April 29, 2013 8:21 AM
To: Dellinger, Philip; McKenzie, Susie; Graves, Brian; Johnson, Ken-E; Lawrence, Rob
Cc: Dwyer, Stacey
Attachments: 2013-04-26 14:23:56 (M2.3) OKLAHOMA 35.7 -97.1 (63093); 2013-04-28 03:06:41 (M3.3) OKLAHOMA 34.2 -96.9 (63093)

Shakes continue

Dorsey, Nancy

From: Dorsey, Nancy
Sent: Wednesday, April 24, 2013 4:41 PM
To: Dellinger, Philip; McKenzie, Susie; Lawrence, Rob; Graves, Brian; Johnson, Ken-E; Dwyer, Stacey
Subject: FW: 2013-04-24 18:04:22 (M3.3) OKLAHOMA 35.7 -97.1 (63093)

From: USGS ENS [mailto:ens@ens.usgs.gov]
Sent: Wednesday, April 24, 2013 4:13 PM
To: Dorsey, Nancy
Subject: 2013-04-24 18:04:22 (M3.3) OKLAHOMA 35.7 -97.1 (63093)

M3.3 - OKLAHOMA

Preliminary Earthquake Report	
Magnitude	3.3
Date-Time	24 Apr 2013 18:04:22 UTC 24 Apr 2013 13:04:22 near epicenter 24 Apr 2013 11:04:22 standard time in your timezone
Location	35.690N 97.089W
Depth	5 km
Distances	10 km (6 mi) ENE of Luther, Oklahoma 26 km (16 mi) NE of Choctaw, Oklahoma 35 km (21 mi) E of Edmond, Oklahoma 36 km (22 mi) SE of Guthrie, Oklahoma 45 km (27 mi) ENE of Oklahoma City, Oklahoma
Location Uncertainty	Horizontal: 41.3 km; Vertical 10.5 km
Parameters	Nph = 0; Dmin = 0.3 km; Rmss = 0.65 seconds; Gp = 0° Version = 5
Event ID	us b000gf1g

For updates, maps, and technical information, see:
Event Page
or
USGS Earthquake Hazards Program

National Earthquake Information Center
U.S. Geological Survey
http://earthquake.usgs.gov/regional/neic/

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To unsubscribe, send a one-line reply to this message with:

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Dorsey, Nancy

From: Dorsey, Nancy
Sent: Friday, March 01, 2013 1:18 PM
To: Dellinger, Philip; McKenzie, Susie; Johnson, Ken-E; Graves, Brian; Lawrence, Rob
Cc: Moore, Keara; Overbay, Michael
Subject: Zoback quoted in AAPG Explorer article

http://www.aapg.org/explorer/2013/03mar/deepfrac0313.cfm

The 'third wave' has begun

Looking Deeper Into Fracturing's Impacts

By DAVID BROWN, EXPLORER Correspondent

"The high fluid pressure in the hydraulic fracture can reawaken or reactivate these (misoriented) faults."

Wouldn't it be great if we understood everything that was happening in hydraulic fracturing?

We aren't there yet.

"We've made tremendous progress. There's no question about that. But I don't think you'll find anyone who would say we've optimized what we do," said AAPG member Mark Zoback, professor of geophysics at Stanford University's School of Earth Sciences.

Recent work by Zoback and his colleagues found that slow slip along misoriented or poorly oriented faults can contribute to high production rates in very low permeability reservoirs.

That response to hydraulic fracturing doesn't show up in routine microseismic monitoring. Understanding this overlooked slippage is key to knowing what occurs in the reservoir following hydrofracturing, Zoback said.

How important is it?

"I don't think shale gas could be produced in many of these reservoirs if this wasn't happening," he said.

In March, Zoback will be the kickoff speaker in Denver at the 19th annual 3-D Seismic Symposium, jointly sponsored by the Rocky Mountain Association of Geologists and the Denver Geophysical Society.

He will speak on "Reservoir Geomechanics Applied to Stimulation of Shale Gas/Tight Gas/Tight Oil Reservoirs."

Zoback's highly regarded text, "Reservoir Geomechanics," is now in its fifth printing from Cambridge University Press, and he brings a reservoir perspective to the development of unconventional resources.

Geologists have long believed that the presence of existing faults and the orientation of those faults can contribute to high production rates in shale gas plays.

Zoback's work indicates those considerations can be even more important than most geologists expected.

More Than Micro

According to Zoback, improved knowledge about hydraulic fracturing's effects on the reservoir can be seen as a third wave of understanding in unconventional resource development.

At first in shale gas plays, "the concept was to make the biggest fracs possible," Zoback noted. "High gel content fluid was used to carry as much sand as possible as far as possible."

Later, more hydraulic fracturing jobs utilized "slickwater," or low viscosity fracturing fluid with friction-reduction additives.

"People then realized you're not making that big of a frac, and you're not using that much sand," he said.

The burst of stimulation from hydraulic fracturing was compared to a micro-earthquake around the well bore, and technicians used monitoring of the microseimic activity to image fracture growth and subsurface response.

That captured the immediate effects of the hydrofracturing. But in addition to induced fractures, other faults in the reservoir can and do become active, according to Zoback.

"I'm saying there are other faults that are slipping slowly, and they are contributing to the production," he said. "More was happening than the microseismicity."

Faults misoriented for slip in the stress field usually would not be expected to be capable of slipping on their own, Zoback said. High pore pressure from hydraulic stimulation can induce slip, however.

He called the misoriented faults "old and dead" faults.

"This is the story for these misoriented faults: The stresses in the Earth are pressing them shut," Zoback explained. "The high fluid pressure in the hydraulic fracture can reawaken or reactivate these faults."

Zoback said the effect of fault slipping on production helps explain why microseismic has not been a good predictor of production rates resulting from successive hydraulic fracturing stages.

"The conventional model of what happens in hydraulic stimulation is that you've got these traditional planes surrounded by microseismic events," he said. "But it's actually very difficult to account for the gas production based on microseismic."

All In the Timing

In a paper he prepared with Arjun Kohli, Indrajit Das and Mark McClure from Stanford University, Zoback wrote:

"The fact that elevated pore pressure initiates slips on misoriented planes is well known from fault mechanics.

"What is not well known is that while slip on a critically stressed fault could propagate rapidly as a micro-earthquake when triggered ... induced slip of misoriented planes will propagate slowly and go undetected during normal microseismic surveys.

“Simply put, the reason for this is that slip on a portion of a misoriented fault will only occur when the pore pressure is anomalously high. Thus, slip will propagate along a misoriented fault only as rapidly as the pore pressure propagates along it.”

In contrast to the fracture growth measured by microseismic, the pressure-induced slow slippage of misoriented faults appears to persist for tens of seconds over tens of meters, he said.

Improved knowledge of reservoir changes from hydraulic fracturing brings several possible implications. One is that shale gas development should proceed from a predictive perspective, rather than hydrofracing with regularized spacing, volumes and rates, Zoback observed.

Zoback’s studies drew on data from hydraulic fracturing in the Barnett Shale and laboratory friction measurements on samples from the Barnett, Eagle Ford, Haynesville and Fort St. John shales. The principles of slow fault slippage generally apply everywhere, he noted.

“I think it’s a fairly ubiquitous phenomenon. It’s not limited to this one case,” he said.

Composition of shales does make a difference, with higher clay content being associated with slower slipping, Zoback said.